PB-227 490

REPORT ON WATER POLLUTION IN THE MAUMEE RIVER AREA, LAKE ERIE BASIN

Federal Water Pollution Control Administration
Chicago, Illinois

August 1966

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Report on Water Pollution

in the

LAKE ERIE BASIN

MAUMEE RIVER AREA

UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION

AUGUST 1966

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REPORT ON

WATER POLLUTION IN THE MAUMEE RIVER BASIN

August 1966

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Great Lakes-Illinois River Basins Project

Cleveland, Ohio

PREFACE

The Department of the Interior is pleased to present this statement on water pollution in the Maumee River Basin.

The action program set forth in this document, when implemented, will protect and enhance the waters of the Maumee River Basin. It will increase the usefulness of these waters for recreational purposes. It will provide a more suitable environment for fish and aquatic life and add to the value of this resource. It will improve the quality of the area's waters for municipal and industrial purposes, esthetic enjoyment, and many other beneficial uses.

Working together as a team, the agencies concerned with the control of water pollution at all levels of government can and will bring this program to fruition for the benefit of the people of Indiana, Michigan, Ohio, and the Nation.

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CHAPTER 1

INTRODUCTION

Authority

Comprehensive water pollution control studies were authorized by the Federal Water Pollution Control Act of 1956, as amended (33 USC 466 et seq.). Initiation of the Great Lakes-Illinois River Comprehensive Program Activity followed an appropriation of funds by the 86th Congress late in 1960. In accordance with the provisions of the Act the Secretary of Health, Education, and Welfare delegated the responsibility for the study to the Division of Water Supply and Pollution Control of the Public Health Service. Passage of the "Water Quality Act of 1965" gave the responsibility for these studies to the Federal Water Pollution Control Administration (FWPCA). As a result of Reorganization Plan No. 2 of 1966, the FWPCA was transferred from the Department of Health, Education, and Welfare to the Department of the Interior effective May 10, 1966.

Purpose

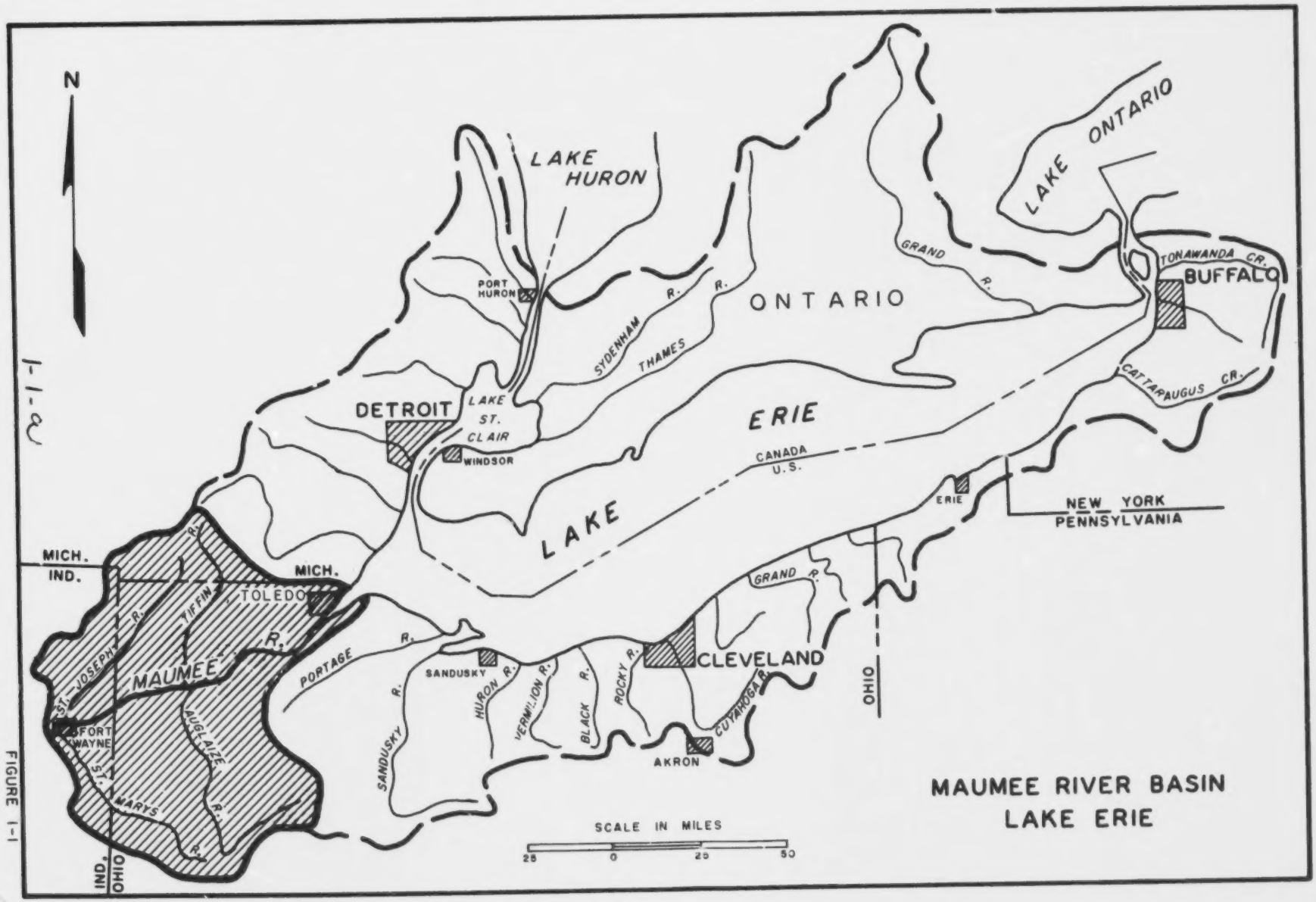
This report presents an action program of water pollution control, geared to provide high quality waters in the Maumee River Basin through abatement of existing pollution, and to provide continuing control of pollution through preventive actions scheduled in anticipation of future problems. This report and resulting program have been developed from both extensive and intensive information on present water quality, water uses and trends in water usage, present and anticipated future waste loads, the existing and projected population and economic growth, and other relevent facts gathered by the Lake Erie Program Office (LEPO), Federal Water Pollution Control Administration, Department of the Interior, during its study of the Lake Erie Basin.

Scope

The area covered by this report includes the waters within the Maumee River Basin and the Toledo area (Figure 1-1). These waters are within Indiana, Michigan, and Ohio.

Organization

The Lake Erie Program Office at Cleveland, Ohio was opened in October, 1962 to begin the Lake Erie study. It is located at 21929 Lorain Road, Cleveland, Ohio. Its staff includes specialists covering the following professional disciplines: sanitary and hydraulic engineering,



1-1-a

FIGURE 1-1

chemistry, biology, bacteriology, and oceanography. The Program has drawn freely on the resources of the Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio and the Communicable Disease Center at Atlanta, Georgia. Additional assistance and guidance in many fields have been obtained from the Great Lakes-Illinois River Basins Project (GLIRBP) office in Chicago.

Acknowledgements

As required by the authorizing legislation, the Lake Erie Program Office has worked closely with State, local, and other Federal agencies to develop a water pollution control program. A list of the principal agencies which have participated through preparation of special reports or through their release of supporting information is as follows:

Michigan:
State Water Resources Commission
Department of Public Health

Indiana:
State Board of Health
Stream Pollution Control Board

Ohio:
Water Pollution Control Board
Department of Health
Department of Natural Resources

U. S. Department of the Army
Corps of Engineers

U. S. Department of Commerce
Weather Bureau
Office of Business Economics

U. S. Department of the Interior
Bureau of Commercial Fisheries
Bureau of Outdoor Recreation
Bureau of Sport Fisheries and Wildlife
Geological Survey

A citizen's group, the Maumee River Basin Water Users Committee, has been especially helpful in defining water uses for various stretches of the principal streams within the basin. This group consists of responsible residents of the Basin representing industries, agriculture, municipalities, recreation and conservation groups, and local and state agencies, all of whom are concerned with the quality and uses of the

waters of the Basin. The following are the chairmen of the various work groups of that Committee:

Municipality Co-Chairmen
Sharon D. Bresler, Lima, Ohio
Paul Fulkerson, Fort Wayne, Indiana

Industry Co-Chairmen
Russell W. Abbott, Libbey-Owens-Ford Glass Co., Toledo, Ohio
Donald E. Bodiker, Sohio Chemical Co., Lima, Ohio

Agriculture Chairman
Charles Young, New Bavaria, Ohio

Recreation Co-Chairmen
Ralph W. Peters, Defiance, Ohio
Carl Mosley, Ohio Department of Natural Resources, Columbus, Ohio

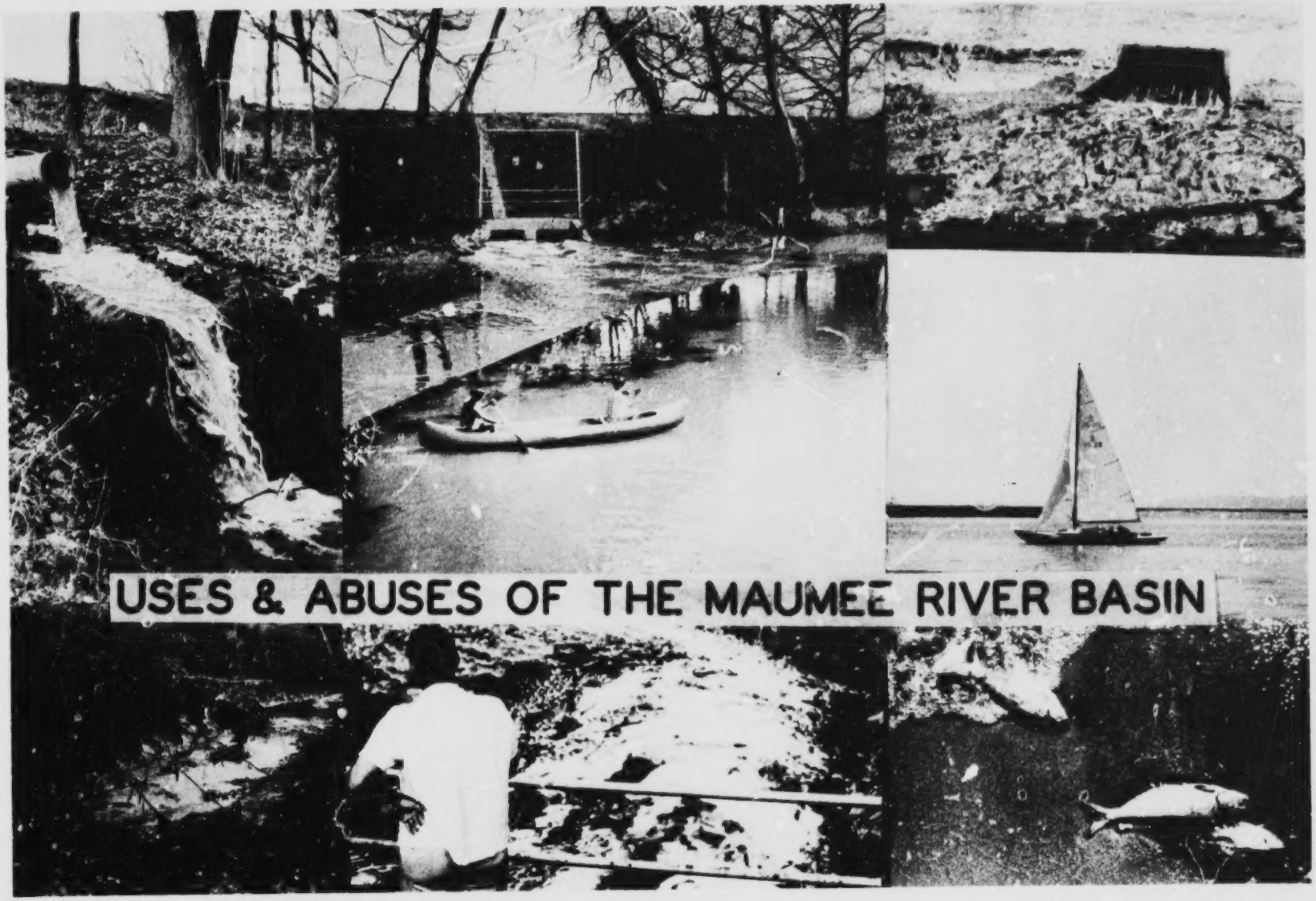


FIGURE 1-2

CHAPTER 2

SUMMARY

The waters of the Maumee River Basin are seriously degraded in quality. The effects of pollution are particularly evident in the Ottawa River, the Upper Maumee River, and the Lower Maumee River at Toledo. All water uses, actual and potential, are influenced by this pollution.

From waters that were once useful and generally free of harmful materials, this River Basin has been degraded in quality to the point where, in several stretches, few legitimate uses may be made of the waters. Not only are activities such as swimming, boating, and fishing no longer available in a number of these locations, but in several areas the water is not even of sufficient quality to be used for waste assimilation. The excellent sport fishery which formerly existed throughout the Maumee Basin is now virtually non-existent.

Biological, chemical, microbiological, and physical parameters analyzed by the Lake Erie Program Office confirm the pollution found in the Basin. Further evidence of pollution cited in this report include the abandonment of the beaches along the Toledo area, the numerous cities and industries which experience tastes and odors in their water supplies, the presence of objectionable algal blooms, and the esthetically disagreeable appearance of many of the waters in the area.

Sources of Pollution

Industry, cities, and agriculture are all major sources of wastes which pollute many of the area's streams. The effluents from the cities' sewage treatment plants seriously depress the receiving waters of oxygen and contribute to the algal growth in many areas. Industrial waste discharges also depress the Basin's rivers of oxygen, cause taste and odor problems in domestic water supplies, and interfere with the esthetic enjoyment of the Basin's water in a number of areas. The runoff from agricultural areas causes turbidity in waters of the area, requires extensive dredging of the shipping channel, and helps to produce the abundant algal growths.

Future Conditions

A population growth projection made by Project economists indicates that the Maumee Basin's population will increase from 1,140,000 to 1,600,000 in 1980 and 2,700,000 by 2020. Industrial activity is also

projected to increase by a considerable amount in the Basin over the same period. Taking into account these and other related factors, it is apparent that the existing degraded conditions will become much worse unless extensive control measures are taken now and continued into the future.

FIGURE 2-1. A. Lake Saint Marys near Saint Marys, Ohio. B. Outfall of the Standard Oil Co. of Ohio on the Ottawa River below Lima, Ohio (note oil in waste and on rocks and bank).

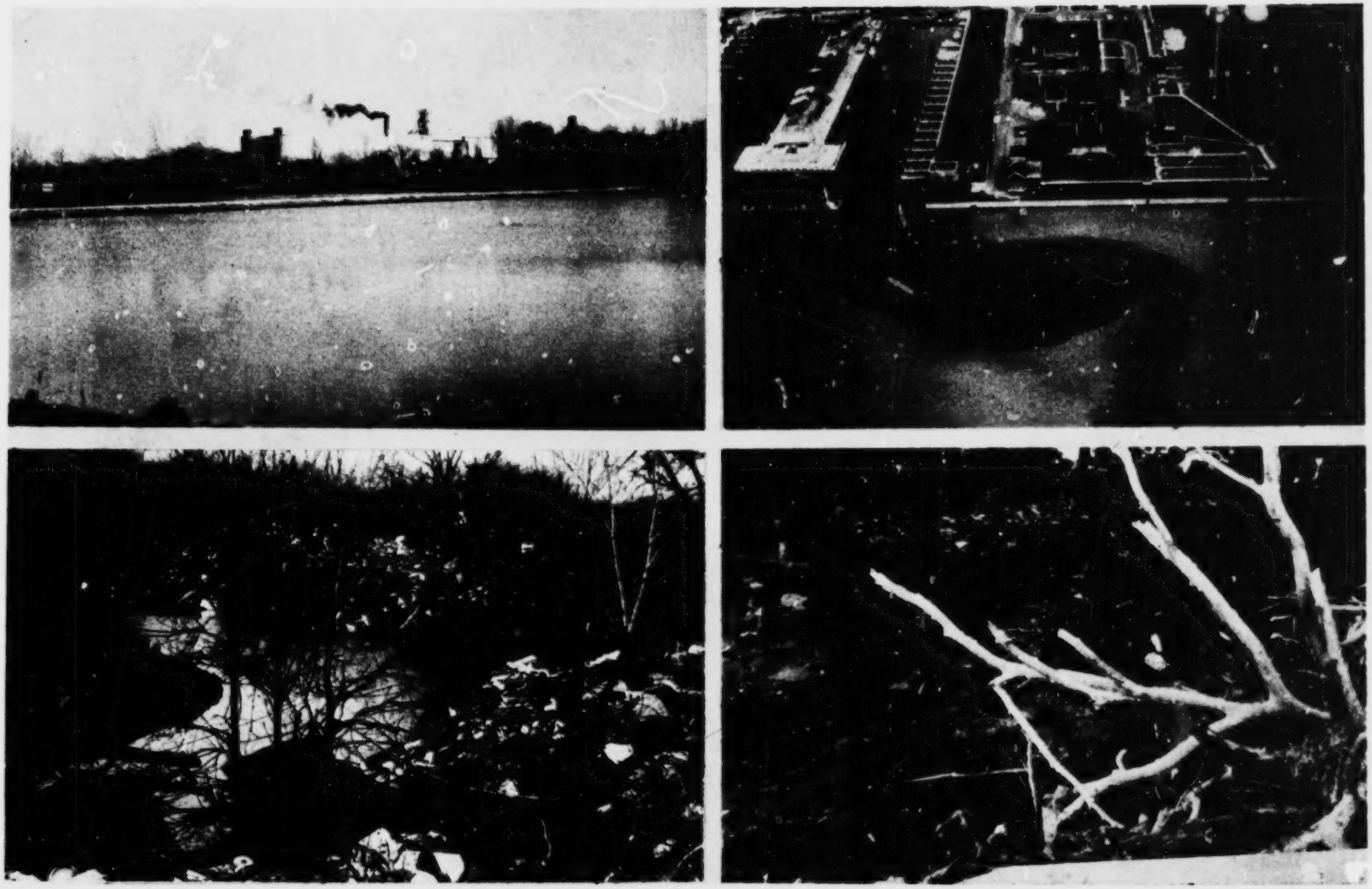


FIGURE 2-2. A. St. Marys R. - Tertiary treatment ponds of Central Soya Co. at Decatur, Indiana. B. Lower Maumee R. - Toledo Sewage Treatment Plant and effluent (dark color) at Toledo, Ohio. C. St. Marys R. - City dump at Willshire, Ohio. D. Little Auglaize R. - algae, debris, and scum at the confluence of the Auglaize R.

CHAPTER 3

RECOMMENDED ACTIONS

The present severe impairment of water uses in the area, and the increasing waste loads which will be imposed on the waste treatment facilities point to the need for the adoption and implementation of a program for water pollution control in the Maumee River Basin. The program, of necessity, must emphasize the construction of new and enlarged sewage facilities; the introduction of tertiary treatment in some areas; the proper operation of new and existing facilities; and the intensive and continuous monitoring of waste treatment operations for maximum efficiency. The recommendations in this chapter represent the initial requirements of a pollution control program for the Basin.

1. All municipal waste treatment facilities should be designed and operated to provide at least secondary (biological) treatment and to achieve an overall reduction in BOD_5 of at least 90 percent on a continuous basis. In certain areas of the Basin, even higher degrees of waste treatment will be required to maintain desirable water quality conditions in the receiving stream. In these instances, particularly below Lima on the Ottawa River, Findlay on the Blanchard River, and Fort Wayne on the Upper Maumee River, some form of advanced waste treatment to achieve a higher reduction of carbonaceous and nitrogenous oxygen demand is a necessity. The major municipal plants and needed improvements are listed in Table 8-1.

2. Continuous disinfection should be provided for all municipal waste treatment plant effluents in this area.

3. Sanitary sewage discharged from industries should receive the same treatment as recommended for municipal wastes.

4. Maximization of phosphate removal, through modification in the operation and/or design of existing and newly constructed secondary waste treatment facilities should be an immediate objective. Records of phosphorus removal at the treatment plants of the Maumee River Basin should be carefully evaluated after one year to determine if significant phosphorus removals have been achieved. If such removals are not achieved, consideration should be given to the installation of chemical precipitation or other treatment facilities at such plants.

5. Streamflow regulation may be necessary in the Maumee River Basin even after a high degree of waste treatment is put into effect, if the desired water quality is to be obtained. However, streamflow regulation is not to be considered as a substitute for the waste

treatment improvement measures recommended.

6. The water pollution control agencies of the States of Indiana, Michigan, and Ohio should conduct municipal and industrial waste treatment plant inspections at least annually for small and medium-sized plants, and at least twice annually for the larger plants.

7. Monthly reports covering the operation of all municipal and industrial waste treatment plants including the quality and quantity of discharged effluent should be submitted to the respective water pollution control agencies of the States of Indiana, Michigan, and Ohio, and there maintained in open files available to anyone having legitimate need for the data.

8. The adoption of a mandatory sewage treatment plant operators' certification program in Indiana is recommended. It is also recommended that the Ohio Department of Health should have stronger enforcement powers to carry out present regulations requiring operator certification.

9. The operation of dams or other flow-retarding structures should be reviewed to insure the maximum practicable stream flow through facilities at low flow times. A survey should be made of obsolete dams to determine which ones can be advantageously removed to eliminate slack-water pools and induce higher velocity streamflow.

10. It is recommended that the water pollution control activities in Indiana and particularly in Ohio be strengthened in terms of staffing and budget. With additional resources and the support available from the Federal Water Pollution Control Administration, the implementation, by the States, of the program outlined herein and similar programs in other basins throughout the States can be accelerated to meet the growing need for clean water.

11. The water quality monitoring program of the Ohio water pollution control agencies in the Maumee River Basin should be strengthened. The program should be geared to indicate change or trends in water quality and the need for additional quality improvement measures.

12. Soil erosion control practices should be improved throughout the Maumee Basin. It is essential that a program for the better utilization of the Basin's land be set up by the respective Soil Conservancy Districts. If the Maumee Basin is to remain a fertile farming area, particular attention must be paid to the control of erosion. Attention must be paid to the proper application of fertilizers and

pesticides. Apart from the value of good land management practices for the land itself, these measures are essential to the reduction of stream turbidity, sedimentation in stream beds, and overfertilization of streams.

13. All separately discharged industrial wastes should receive at least the equivalent of secondary treatment, as described above for domestic wastes, and no waste constituents should be discharged which will adversely affect the receiving waters. Phenols in the waste waters of several industries in the area are particularly harmful in terms of the resulting water quality problems. Industrial waste treatment facilities should be designed and operated to achieve the maximum possible reduction of phenols. Where practicable, industrial wastes should be discharged to municipal sewerage systems. However, where significant concentrations of waste concentrations are encountered which would upset normal treatment, pretreatment and controlled discharge of industrial wastes is necessary. Facilities should be installed to prevent accidental spills or leakages of all concentrated solutions and oils from entering any stream either directly or through municipal sewer systems. The major industries needing improvements are listed in Table 6-2.

14. All new sewerage systems should be designed to prevent the necessity of bypassing untreated waters.

15. Disposal of sludges, digestion liquors, garbage, trash, and other deleterious refuse in the Maumee River and its tributaries should be prohibited; existing dumps along the river banks, such as at Willshire, Ohio, should be removed.

16. Combined sewers should be prohibited in all newly developed urban areas and should be separated in coordination with urban renewal projects. Existing combined sewer systems should be patrolled and overflow regulating devices should be adjusted to convey the maximum practicable amount of combined flow to treatment facilities.

CHAPTER 4

DESCRIPTION OF AREA

Geography

The Maumee River drains 6,586 square miles, of which 19 percent is in Indiana, 7 percent is in Michigan, and the remainder is in Ohio. The St. Marys and St. Joseph Rivers join to form the Maumee River at Fort Wayne, Indiana. At Defiance, Ohio two more tributaries join the Maumee River. The Tiffin enters from the north, and the Auglaize enters from the south.

Hydrology

The stream flow within the Maumee River Basin is unusual in the respect that the general direction of flow of the major tributaries is not towards Lake Erie (east), but is, in fact, away from the Lake towards the west. This general characteristic is the result of glacial deposits.

Table 4-1 lists the stream characteristics of the major rivers in the Maumee River Basin. The majority of the Basin and the area surrounding it is generally quite flat. In fact, major flood flows at Fort Wayne, Indiana can and have crossed the low divide between the

TABLE 4-1

MAUMEE RIVER BASIN STREAM CHARACTERISTICS

River	Drainage area* (sq. miles)	Length of main stem (miles)	Average fall (ft./mile)
St. Joseph	1,060	93	1.6
St. Marys	817	100	2.9
Tiffin	804	103	1.3
Auglaize	1,313	102	3.2
Blanchard	762	91	0.9
Ottawa	373	53	4.0
Maumee	1,457	136	1.3
	6,586		

* Excluding separately listed tributaries

Maumee and the Wabash River system. As an example of the flatness of the Basin, it should be noted that, in the 136 mile length of the main stem, the Maumee River drops approximately 170 feet, or about 1.3 feet per mile of length.

Table 4-2 is a tabulation of the dependable yields for the major streams in the Maumee River Basin based on a low 7-day, once-in-five-years flow. Figure 4-1 shows the location of the permanent gaging stations monitored by the U. S. Geological Survey, and the temporary gaging stations established by the LEPO. For the majority of the Maumee Basin, the topography and soil conditions in the area are such that there is very little bank storage or other recharging available from the ground water to the rivers. The peak discharge for a 39 year period at the Waterville gage on the Maumee River was 94,000 cfs, while the minimum was 30 cfs. Both of these discharges are relatively low for a river with as large a drainage area as the Maumee. This is true for the entire Basin. All rivers in the Basin have low, mean, and high flows that are relatively small compared to flows of average streams for the same drainage area. When a heavy rainfall occurs in the Basin, the water tends to back up or pile up in the tributaries, flooding many of the low areas. Thus, water takes several days to run off an area where the land would normally drain in a few hours if a greater slope were present.

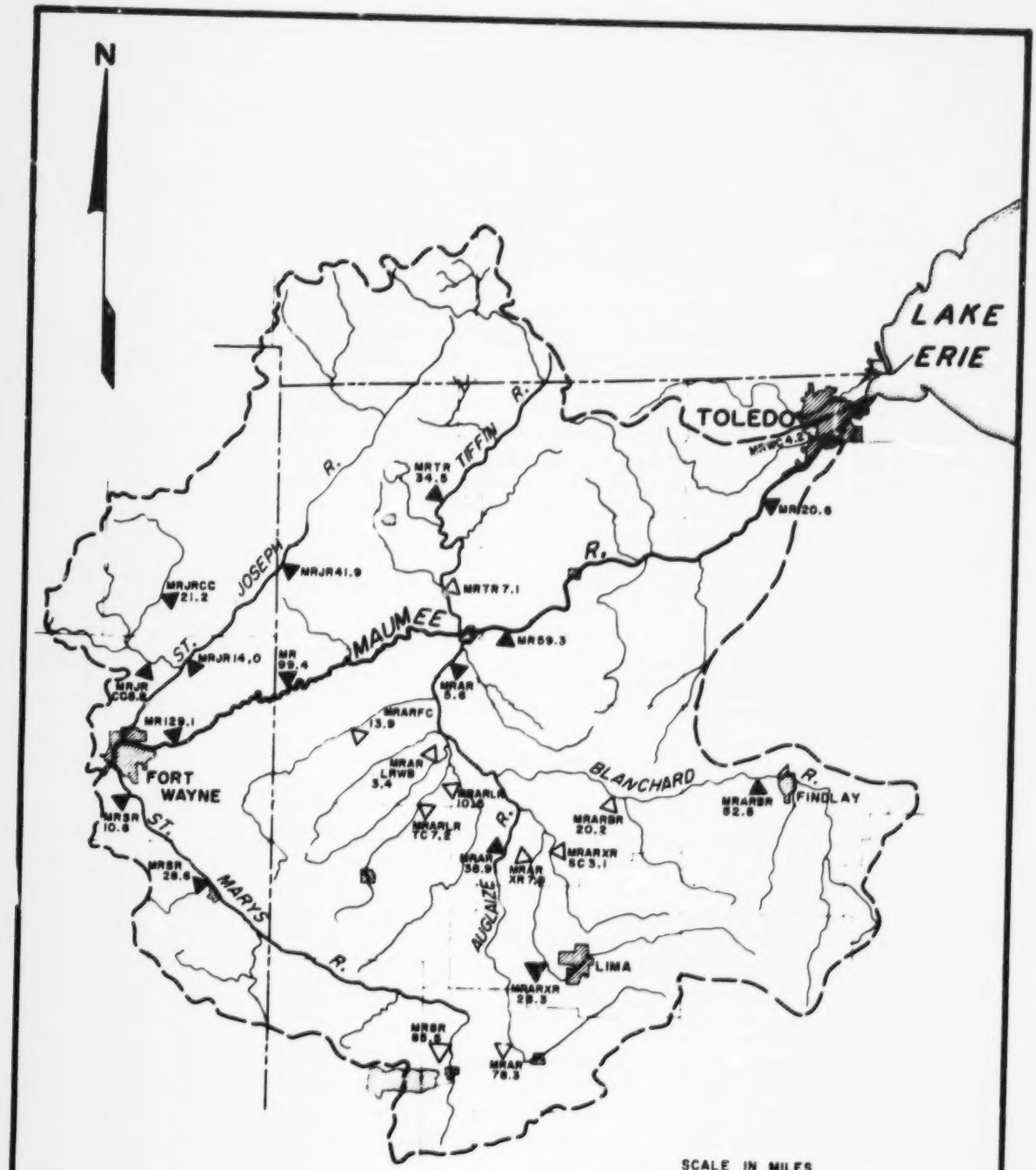
TABLE 4-2

DEPENDABLE YIELDS FOR
MAJOR STREAMS IN MAUMEE BASIN(25,26)

River	Location	Drainage Area (sq. miles)	Period of record (years)	Yield* (cfs)
Maumee	Waterville, O.	6,314	34	90
	Antwerp, O.	2,049	33	68
St. Joseph	Neville, Ind.	614	13	21
St. Marys	Fort Wayne, Ind.	753	29	10
Tiffin	Stryker, O.	441	29	12
Auglaize	Defiance, O.	2,329	44	14.5
Blanchard	Findlay	343	30	4
Ottawa	Allentown, O.	168	27	15

* Low seven-day, once-in-five-year flows from Ohio Department of Health.

Artificial drainage has been an indispensable element in the development of agriculture in the Maumee Basin. In the last 50 years, many large areas have been drained for farming, either by surface ditching or tiling or both, but many of the early tile systems have lost



▶ – GAGING STATIONS, U. S. GEOLOGICAL SURVEY.

▷ – GAGING STATIONS, L. E. P. O.

MAUMEE RIVER BASIN STREAM GAGING STATIONS

4-2-a

FIGURE 4-1

their effectiveness and there is a need for new and additional tile systems.

Typical maximum and minimum flows for some of the tributaries to the Maumee are as follows: Auglaize River - 52,000 cfs and 0.5 cfs; St. Marys River - 13,600 cfs and 3.4 cfs; St. Joseph River - 10,000 cfs and 1.6 cfs; and the Tiffin River - 6,640 cfs and 3.6 cfs.

In many areas, such as on the Ottawa River at the City of Lima, there is virtually no flow through the city during the critical low flow months. What flow there is above Lima is used for water supply. Below Lima, the flow of the river consists exclusively of the effluent from a sewage treatment plant, a chemical plant, and a refinery. Lima's sewage treatment plant discharges 5 mgd into the Ottawa River, and SOHIO discharges 10 mgd which it has removed from ground water storage. This is why extreme pollution conditions exist in many such areas in the Basin where communities are located near the headwaters of a river. These conditions are described in detail in Chapter 8.

The only relatively steep area of the Basin is the northern or Michigan sector. Bean Creek, which is the headwaters of the Tiffin River, falls over 300 feet from its origin at Devils Lake to the Ohio border in a distance of 20 miles. This is a fall of 15 feet per mile as compared to the fall of the Tiffin River from the Ohio border to the Maumee River of 1.2 feet per mile.

Ground Water

The ground water in the Maumee Basin is obtained from both glacial drift and limestone formations. The problem with ground water in the Maumee Basin is one of quality rather than quantity. The ground water generally is hard and contains excessive quantities of iron and manganese. Hydrogen sulfide is found in much of the water in wells drilled in limestone and in sand and gravel formations which have a hydraulic connection with sulfur bearing limestone. (39)

Reservoirs

Generally, large reservoir impoundments are not feasible on the Maumee River because of the flatness of the land. Some reservoir sites are available in the headwaters of the Basin, but these impoundments would not control large drainage areas.

The State of Ohio has studied 287 reservoir sites. Of these, nine were considered suitable for multiple-purpose water resource developments. Four of the sites are located above Findlay, Ohio in the southeastern part of the Basin. Those remaining are located as follows: Lima, Ohio area, 2 sites; St. Marys, Ohio area, 1 site; and the Ohio-

Michigan border area, 2 sites. Individual impoundment sites would control from 25 to 161 square miles in drainage area and the potential storage varies from 2.4 to 13.2 inches of runoff (53).

There are a number of old or out-of-use dams and other flow-retarding structures throughout the Basin. These form slack water pools and reduce the velocity of the rivers. For reasons not completely understood, algae flourish more readily in sluggish waters, as in these slack water pools or lakes, than in flowing streams. Also, by reducing the velocity and significantly increasing the depth of flow, the rate at which an oxygen depletion can be satisfied is affected. It might be beneficial to remove these retarding structures if their adverse effect on water quality outweighs their recreational or other value.

Topography and Soils

For many years, the major portion of this region was known as the Great Black Swamp, barrier to transportation and to settlement alike (12). Nowhere else in Ohio are there such extensive areas of flat landscape. The principal features to break the monotony are the old beach ridges and recessional moraines which lie in the plain-like great decorative chains about western Lake Erie. All of the Maumee River Basin topography has been affected by glaciation, most of the Basin being of flat relief as a result of inundation by the ancient glacial lake. During glacial periods, the gravity outlet through the St. Lawrence Basin was blocked by the ice sheet, and the ice melt from the glaciers drained into the Mississippi River system by flowing across the topographic saddle at Fort Wayne.

The soils of the Till Plains developed from moderately fine-textured high lime Wisconsin glacial till. The principal soils are those of the Morley, Blount, and Pewano series that generally are moderately permeable. Over the Lake Plain portion of the Basin, the principal soils, also of Wisconsin age, are predominantly fine-textured, poorly drained, and relatively impermeable. Low dry-weather stream flows reflect the impermeable characteristics of the soils in the Basin (35). The glaciated uplands contain more sloping land and a higher percentage of better-drained soils. Some strongly sloping land occurs near the streams and in a belt of land about 10 miles wide running southwest along the northern edge of the Basin.

Climate

A major factor influencing the climate of the Maumee Basin is its location relative to major storm tracks. Low pressure centers from the Gulf of Mexico usually pass to the south of the Basin. High pressure centers from the north and northwest pass across the Great Lakes region,

north of the Basin. The prevailing winds from the south and southwest make the Maumee Basin less subject to severe storms and heavy rainfall.

The average annual air temperature is 50-51°F for the Basin. The highest mean monthly temperature occurs in July and is 74°F, while a low of 29°F occurs in January. In 63 years of record at Fort Wayne, the highest and lowest recorded temperatures were 102°F and -24°F respectively.

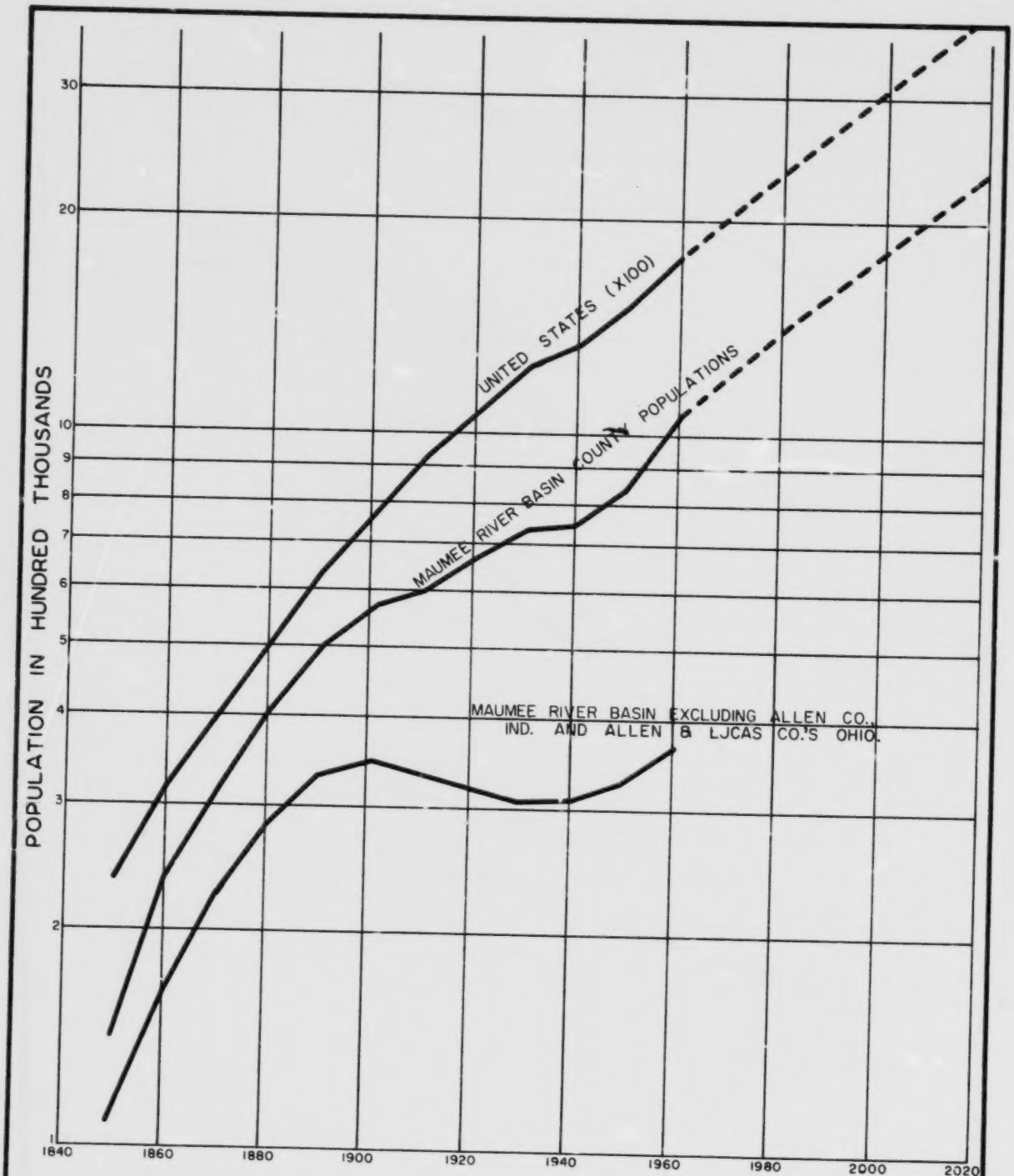
Average annual precipitation for the period 1931-1960 ranges from 36 inches in the Lima area to 32 inches in the Toledo area (19). Average annual stream flows in inches for the period 1931-1960 range from 11 inches at Fort Wayne to 8 inches at Toledo. The difference between the average rainfall and average streamflow is considered to be the average water loss, and is about 25 inches annually for the Maumee River Basin.

Population

The 1960 population of the Maumee River Basin and the Greater Toledo area was approximately 1,140,000. Of this number, 72 percent was in Ohio, 24 percent was in Indiana, and the remaining 4 percent was in Michigan. Projected population estimates give 1.6 million for 1980 and 2.7 million for 2020. Only a slight shift in the distribution among the three states is expected. This will result from the rapid increase in the Michigan portion of the Greater Toledo area as the urban area expands northward. Approximately 76 percent of the 1960 population, or 865,000 persons, resided in municipal areas. This is expected to increase to 1.2 million (80 percent) by 1980 and to 2.2 million (84 percent) by 2020.

The population growth rate of the Maumee River Basin (Figures 4-2 and 4-3) during the last half of the nineteenth century kept pace with the rate experienced by the entire United States. After the turn of the century, the population expansion of the Basin fell behind the national growth rate. Between 1890 and WW II, the population distribution was influenced by the increased manufacturing activity and the accompanying economic development of metropolitan areas. This is clearly illustrated (Figure 4-2) by the increasing populations of Lucas (Toledo), Allen (Lima), and Allen (Fort Wayne) counties which occurred during this period while the remainder of the Basin's population was constant or decreasing. It was not until the middle 1950's that the population of the non-metropolitan area reached the population recorded in 1890.

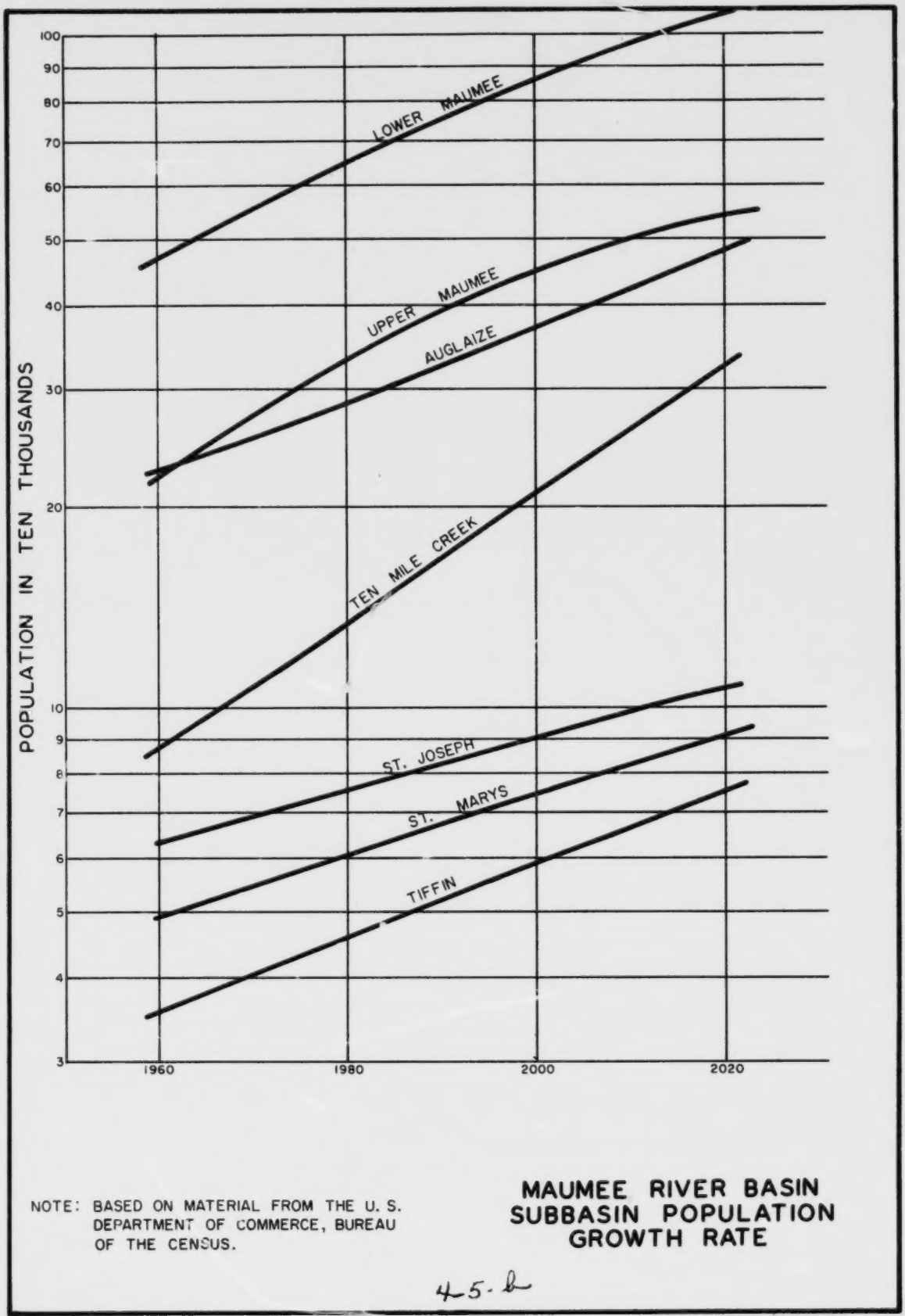
The six subbasins of the Maumee River Basin and the Greater Toledo area differ greatly in population characteristics. The St. Joseph, St. Marys, and Tiffin subbasins have the smallest population. In 1960 each of them had a density of less than 60 persons per square mile with the



NOTE: BASED ON MATERIAL FROM THE U. S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS.

MAUMEE RIVER BASIN
POPULATION GROWTH RATE

FIGURE 4-2



NOTE: BASED ON MATERIAL FROM THE U. S. DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS.

MAUMEE RIVER BASIN SUBBASIN POPULATION GROWTH RATE

4-5.b

FIGURE 4-3

Tiffin Subbasin having the lowest density of 44 persons per square mile. The St. Joseph Subbasin, with its 1960 population of 62,900, 59 percent of which was municipal, is not expected to grow appreciably in the near future. Even by 2020, only a 70 percent increase is anticipated with no significant change in the municipal percentage. The Tiffin Subbasin, although the most rural in 1960 with a municipal percentage of only 50, is forecasted to increase from 35,500 in 1960 to 77,000 by 2020 with two-thirds of the population residing in municipalities. The projections for the St. Marys Subbasin give a 2020 population of 91,000, which is an 86 percent increase over the 1960 figure of 49,000. The Indiana portion of the St. Marys Subbasin is expected to have a large increase in municipal population between 1960 and 2020 which in turn will raise the municipal percentage for the entire subbasin to 72 percent.

The Auglaize River Subbasin is the largest, with some 2,500 square miles of drainage area. In addition to a rural population similar to the previously described subbasins, it supports the industrial complexes of Lima and Findlay. Its 1960 population of 225,000 is expected to increase to almost half a million by 2020. The corresponding change in municipal percentage is from 62 to 75 percent.

The Upper and Lower Maumee Subbasins and the Greater Toledo area are highly populated. Each had 1960 densities exceeding 425 people per square mile. The Upper Maumee population, which consists mainly of the City of Fort Wayne, is expected to increase from its 1960 population of 221,000 to 328,000 in 1980 and to 540,000 in 2020. After 1980, a continuous decrease is anticipated in its rate of growth. A small increase in the municipal percentage is forecasted for 2020.

The City of Toledo sets the pace for the population growth of the Lower Maumee Subbasin. Although the Lower Maumee covers a large rural area, its 1960 population of 462,000 was about 87 percent municipal. It is anticipated to increase to 640,000 in 1980 and to over one million in 2020 with a corresponding increase in municipal percentage to 94 percent for 2020.

The Tenmile Creek Subbasin is expected to have the highest growth rate in the Greater Toledo area. By 2020, the population of the Michigan section of this subbasin is forecasted to exceed the Ohio portion's population. Population estimates for the Tenmile Creek basin give 134,000 for 1980 and 320,000 for 2020 compared to 87,100 in 1960. The municipal proportion is projected to increase from 82 to 85 percent.

Economy

The following section is a discussion of the present and future economy of major sectors of the area.

Industry

The Maumee River Basin is a major industrial area. In 1963, the Value Added by Manufacture (VAM) was 1.9 billion dollars, an increase of 35 percent over the 1958 value. Over 140,000 people are employed in manufacturing. Over 750 manufacturing establishments in the Basin employ twenty or more people. The principal industries are machinery, metal fabrication, food, and transportation equipment.

The major industrial centers are Toledo and Lima in Ohio and Fort Wayne in Indiana. The 1963 VAM in Lucas County was over 700 million dollars, or roughly 40 percent of the VAM for the Maumee River Basin. The manufacturing balance in Toledo is heavily weighted in favor of durable manufacturing goods (transportation equipment; stone, clay and glass; and primary and fabricated metals). The important nondurable goods are petroleum and coal, food and kindred products, and paper and printing.

The General Electric Company, which makes electrical apparatus, and International Harvester, which manufactures heavy-duty motor trucks and component parts, are the major industries in Fort Wayne. Other important durable goods produced are primary and fabricated metals. The major nondurable goods are rubber, paper, and food products. In 1963, the VAM in Allen County was over 400 million dollars.

Lima is the smallest of the three industrial centers. Its 1963 VAM exceeded 200 million dollars. As in the other industrial areas in the Basin, a substantially larger number of persons are employed in the production of durable goods (metal products, machinery, and equipment) than in the production of nondurable goods. Increases in nondurable goods have occurred in textile products, and food and kindred products. Major industries include transportation equipment, petroleum refining, and chemicals.

Industrial projections have been made by economic subregions up to the year 2020. Manufacturing employment is expected to grow most rapidly in the subregions, which include **Toledo, Lima and Ft. Wayne.** Industrial activity in the Basin is projected to increase threefold by 1990 and to grow to nine times its 1960 level by the year 2020. Due to increased efficiency in the use and reuse of water, industrial water intake and waste flows will grow at a considerably slower rate than manufacturing output.

Agriculture

The farmlands of the Maumee River Basin support a productive agricultural economy. Over 90 percent of the land in the Basin is in agricultural use. In 1959, the value of all farm products sold was about 230 million dollars, with 46 percent of this from crops and the remainder related to livestock. The average size of the 30,000 farms is over 130 acres. General farming has provided a diversified agricultural production and a stable economy. The Basin's principal crops are the "big four" of the Corn Belt--corn, wheat, oats, and soybeans. In addition, there is a sizable production of cattle, hogs, sugar-beets, truck farming (such as tomatoes and sweet corn), and nursery stock. In 1950, 51 percent of the farm income was derived from the sale of crops for cash, and 34 percent of all farms were classified as cash grain. The production of pork and beef contributes about one-fourth of all farm income, and dairying and poultry raising provide the remainder.

Soybean production is centered in the Lower Maumee and Auglaize River Basins in the counties of Van Wert, Henry, Putnam, Hancock, and Paulding. Corn is grown throughout the Basin. An important area for raising cattle, calves, and poultry products is Fulton County, Ohio. Hog production is prevalent in the St. Marys River Basin in the counties of Adams and Mercer, Ohio.

Commerce

Toledo is the commercial center of the Maumee River Basin. Commercial goods can reach the city by highway, railway, inland waterway, and pipeline. The city's port, ninth largest in the United State, is the largest shipper of soft coal in the world. About thirty million tons of soft coal pass through the port annually. Other important commodities are grain, iron ore, and petroleum products. The port is also a growing center for overseas commerce, exporting farm products and machinery. Toledo ranks as the largest port on Lake Erie and is second only to Chicago in the Great Lakes. From 1959 to 1964, its tonnage increased about 430 percent to 42 million tons. This increase coincided with the opening of the St. Lawrence Seaway (9).

Lima, Ohio is the center of an oil distribution system with pipelines extending from the oil fields of Wyoming, Texas, and Oklahoma to the Great Lakes and Eastern markets. Since the 1880's, Toledo has maintained contact by pipeline with the westward-expanding oil and gas fields and is the largest petroleum refining center between Chicago and the eastern seaboard.

Toledo ranks as the nation's third largest railroad center. It

serves as an interchange of much east-west rail traffic with coal, iron ore, and agricultural commodities as the principal items.

The new interstate system of highways provides better accessibility to various sections of the Basin. As it progresses from Detroit to Cincinnati, Interstate 75 joins Toledo with the industrial areas of Findlay and Lima. The Ohio Turnpike (Interstate 80 and 90) is the major route between Chicago and Cleveland. The Fort Wayne area is served by the north-south Interstate 69.

Mining and Lumbering

Natural resources within the Maumee Basin are nonmetallic and do not form an important base of the economy. Sands and gravels are surface mined throughout the Basin where glacial moraines are present. Hard limestone is dug from open quarries where the drift is relatively thin.

Gas and oil resources were discovered in the eastern portion of the watershed in the late nineteenth century, but these deep wells have largely been abandoned with the gradual depletion of the resources. Lumbering was substantial in the early settlement of the Basin, but the forests have been cleared for agricultural use, and only small, scattered woodlots remain, which constitute less than 8 percent of the Basin's area.

Tourism

At present, tourism is not significant in the Maumee River Basin. Parks and other points of interest are limited in number. The only large lake, Lake St. Marys, is located on the southern perimeter of the Basin. A few state parks exist within the Basin, but these do not appear to attract many persons outside of the local communities. Boating, fishing, and other water-oriented recreation are not prevalent due to poor water quality and limited access to the streams. Most of the tourists are probably from the surrounding, highly populated cities or as passing through the region on the way to their planned destination. However, there are several areas that may be of importance in the future.

The Ohio Department of Natural Resources has proposed a state-operated parkway along the old Miami Erie Canal. U. S. Route 24 from Toledo to Defiance and Ohio Route 111 from Defiance to Paulding would be developed and landscaped. Parking and picnic areas, tent and trailer camps, cabins and lodges, marinas and fishing piers, and hiking and bridle trails are planned to adjoin the parkway. The Vogt-Ivers Report (5) on this plan predicts that, if the Maumee River service area is developed to its fullest potential, it could attract 5,000,000 annual visits by 1980.

The Allen County, Indiana, Planning Commission has proposed a series of park and recreational areas which would serve primarily the Fort Wayne area, but would also hope to attract people from outside the immediate area. The City of Fort Wayne itself has also taken steps to attract summer tourists.

CHAPTER 5

WATER USES

The principal water uses in the Maumee River Basin include:

Municipal water supply
Industrial process water
Recreation
Irrigation
Fish and aquatic life
Wildlife and stock watering
Commercial shipping
Cooling water supply
Waste water assimilation
Esthetics

Table 5-1 is a mile point description of the stream sector boundaries as used in this report, and Figure 5-1 shows their location. The sector boundaries were based on a consideration of changing water quality, changes in water uses, and/or certain physical features of the area. Table 5-2 lists the water uses found in the various sectors as were determined for the study area. These water uses were developed in cooperation with the States of Indiana, Michigan, and Ohio and the Maumee River Basin Water Users Committee Chairmen. However, full responsibility for these uses is assumed by this office. The major water uses of the area are discussed in the following sections of this chapter.

Municipal Water Supply

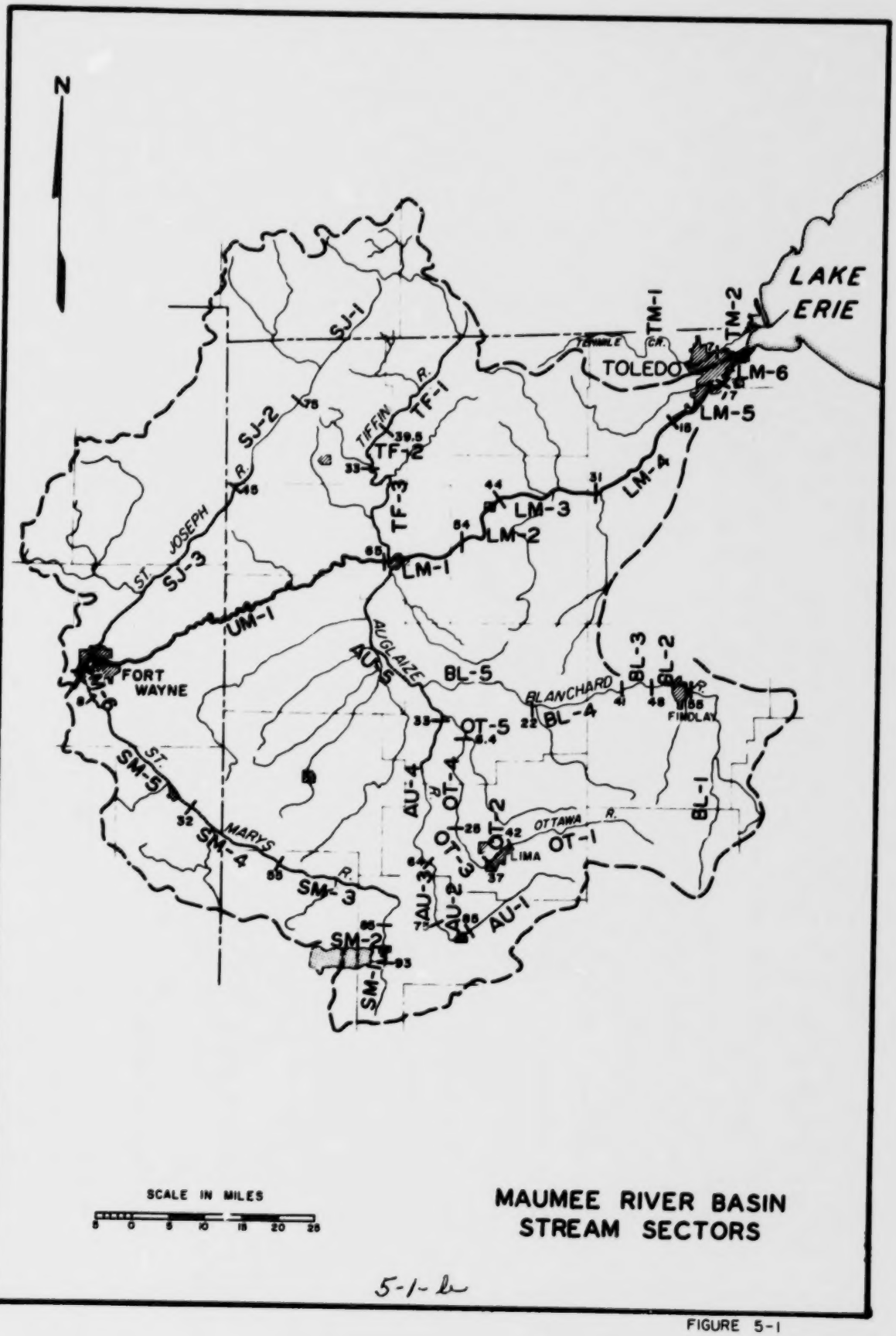
The total municipal water use by 171 communities in the watershed amounts to 128 mgd, of which 113 mgd are obtained from surface supplies and 15 mgd from underground supplies. Table 5-3 lists the present and projected municipal water usage for principal service areas in the Maumee River Basin.

Five municipalities obtain their water supply directly from the Maumee River. These Ohio communities are Waterville, Bowling Green, Grand Rapids, Napoleon, and Defiance. The City of Fort Wayne, Indiana uses the St. Joseph River as a source of water supply. The communities of Archbold, Wauseon, Findlay, Van Wert, Lima, Delta, Weston, and Swanton, Ohio have impounding reservoirs. The City of Toledo and its satellites draw an estimated 70 mgd from Lake Erie.

TABLE 5-1

STREAM SECTORS

Stream	Sector	Description
St. Joseph River	SJ-1	Headwaters - Mile point 75
	SJ-2	Mile point 75 - 45
	SJ-3	Mile point 45 - mouth
St. Marys River	SM-1	Headwaters - Mile point 93
	SM-2	Mile point 93 - 85
	SM-3	Mile point 85 - 55
	SM-4	Mile point 55 - 32
	SM-5	Mile point 32 - 8
	SM-6	Mile point 8 - Mouth
Upper Maumee River	UM-1	Mile point 65 - Head
Tiffin River	TF-1	Mile point 39.5 - Head
	TF-2	Mile point 33 - 39.5
	TF-3	Mile point 0 - 33
Ottawa River	OT-1	Mile point 42 - Head
	OT-2	Mile point 37 - 42
	OT-3	Mile point 25 - 37
	OT-4	Mile point 6.4 - 25
	OT-5	Mile point 0 - 6.4
Blanchard River	BL-1	Headwaters - Mile point 55
	BL-2	Mile point 55 - 48
	BL-3	Mile point 48 - 41
	BL-4	Mile point 41 - 22
	BL-5	Mile point 22 - Mouth
Auglaize River	AU-1	Headwaters - Mile point 85
	AU-2	Mile point 85 - 75
	AU-3	Mile point 75 - 64
	AU-4	Mile point 64 - 33
	AU-5	Mile point 33 - Mouth
Lower Maumee River	LM-1	Mile point 54 - 65
	LM-2	Mile point 54 - 44
	LM-3	Mile point 44 - 31
	LM-4	Mile point 31 - 15
	LM-5	Mile point 15 - 7
	LM-6	Mile point 7 - Mouth
Tenmile Creek	TM-1	Headwaters - Mile point 7
	TM-2	Mile point 7 - Mouth



MAUMEE RIVER BASIN
STREAM SECTORS

5-1-b

FIGURE 5-1

TABLE 5-2
WATER USES BY SECTORS

Water Uses	Sectors								
	SJ-1	SJ-2	SJ-3	SM-1	SM-2	SM-3	SM-4	SM 5	SM-6
Municipal Water Source	-	A	P	-	A	A	A	A	-
Industrial Process Water	-	A	P	A	A	A	A	P	P
Whole Body Contact Recreation	-	P	P	A	A	A	A	A	P
Partial Body Contact Recreation	P	P	P	P	P	P	P	P	P
Irrigation	P	P	P	P	A	P	P	P	-
Fish - Well Rounded Stream	P	P	P	P	P*	-	-	P	-
Fish - Well Rounded Pool	P	P	P	-	-	P*	P	-	P*
Fish - Minimum	P	P	P	P	P	P	P	P	P
Wildlife and Stock Watering	P	P	P	P	-	P	P	P	-
Hydropower	-	-	P	-	-	-	-	-	-
Commercial Shipping	-	-	-	-	-	-	-	-	-
Cooling	-	A	P	A	P	A	A	A	P
Wastewater Assimilation	P	P	P	P	P	P	P	P	P
Esthetics	P	P	P	P	P	P	P	P	P

"P" = Present and anticipated future use of the stream sector.
"A" = Anticipated possible future use.
"-" = No present or future use anticipated.
* Use presently adversely affected by pollution.

TABLE 5-2 (Continued)
WATER USES BY SECTORS

Water Uses	Sectors								
	UM-1	TF-1	TF-2	TF-3	OT-1	OT-2	OT-3	OT-4	OT-5
Municipal Water Source	P	P	A*	A	P	-	-	-	-
Industrial Process Water	P	P	A	A	A	-	A	A	A
Whole Body Contact Recreation	P*	P	P	P	P	-	-	-	
Partial Body Contact Recreation	P*	P	P	P	P	P*	P*	P*	P*
Irrigation	P	P	P	P	P	-	A	A	A
Fish - Well Rounded Stream	P*	P	P	-	P	-	-	P*	P*
Fish - Well Rounded Pool	P*	-	-	P	-	P*	P*	P*	P*
Fish - Minimum	P	P	P	P	P	P*	P*	P*	P*
Wildlife and Stock Watering	P	P	P	P	P	-	P*	P*	P*
Hydropower	-	-	-	-	-	-	-	-	-
Commercial Shipping	-	-	-	-	-	-	-	-	-
Cooling	A	A	A	A	A	-	A	A	A
Wastewater Assimilation	P	P	P	P	P	P	P	P	P
Esthetics	P	P	P	P	P	P*	P*	P*	P*

"P" = Present and anticipated future use of the stream sector.
"A" = Anticipated future use, but not present use.
"-" = No present or future use anticipated.
* Use presently adversely affected by pollution.

TABLE 5-2 (Continued)
WATER USES BY SECTORS

Water Uses	Sectors									
	BL-1	BL-2	BL-3	BL-4	BL-5	AU-1	AU-2	AU-3	AU-4	AU-5
Municipal Water Source	P	-	-	P	P*	A	-	P*	P	-
Industrial Process Water	-	P	A	P	P	A	A	A	P	-
Whole Body Contact Recreation	-	-	-	P*	-	P	-	-	-	P*
Partial Body Contact Recreation	P	P*	P*	P	P*	P	P	P	P	P*
Irrigation	P	-	P	P	P	P	P	P	P	P
Fish - Well Rounded Stream	P	P*	P*	-	-	P	P*	P*	P	-
Fish - Well Rounded Pool	-	-	-	P*	P*	-	P*	-	P	P*
Fish - Minimum	P	P*	P*	P	P*	P	P	P	P	P*
Wildlife and Stock Watering	P	-	P	P	P	P	P	P	P	P
Hydropower	-	-	-	-	-	-	-	-	-	-
Commercial Shipping	-	-	-	-	-	-	-	-	-	-
Cooling	A	A	A	A	P	P	A	-	P	A
Wastewater Assimilation	P	P	P	P	P	A	P	A	P	P
Esthetics	P	P*	P	P	P*	P	P*	P	P	P*

"P" = Present and anticipated future use of the stream sector.
"A" = Anticipated possible future use.
"-" = No present or future use anticipated.
* Use presently adversely affected by pollution.

TABLE 5-2 (Continued)
WATER USES BY SECTORS

Water Uses	Sectors							
	LM-1	LM-2	LM-3	LM-4	LM-5	LM-6	TM-1	TM-2
Municipal Water Source	P*	P*	P*	P*	-	-	-	-
Industrial Process Water	P	P*	A	P*	P*	P*	A	P
Whole Body Contact Recreation	P*	P	A	P*	P*	P*	A	P*
Partial Body Contact Recreation	P	P	P	P*	P*	P*	P	P*
Irrigation	P	P	P	P	P	-	P	-
Fish - Well Rounded Stream	P*	-	-	P*	-	-	P	-
Fish - Well Rounded Pool	P*	P	P	P*	P*	P*	-	P*
Fish - Minimum	P	P	P	P	P*	P*	P	P*
Wildlife and Stock Watering	P	P	P	P	-	-	P	-
Hydropower	-	-	-	-	-	-	-	-
Commercial Shipping	-	-	-	-	-	P	-	-
Cooling	P	P	P	P*	P	P*	A	P
Wastewater Assimilation	P	P	P	P	P	P	P	P
Esthetics	P*	P	P	P	P*	P*	P	P*

"P" = Present and anticipated future use of the stream sector.
"A" = Anticipated future use, but not present use.
"-" = No present or future use anticipated.
* Use presently adversely affected by pollution.

TABLE 5-3

MAUMEE RIVER BASIN
PRESENT AND PROJECTED WATER USAGE
IN PRINCIPAL SERVICE AREAS

	Population Served (1962)	Demand 1962 (mgd)	Demand 1980 (mgd)	Demand 2020 (mgd)
Montpelier	4,500	0.5	0.7	1.4
St. Marys	9,000	0.7	1.1	2.4
Decatur	8,000	0.8	1.3	2.5
Findlay	35,000	5.1	7.8	17
Ottawa	3,400	0.4	0.6	1.2
Lima	58,000	11	17	37
Wapakoneta	8,000	0.7	1.0	2.4
Fort Wayne	169,000	24	36	71
Defiance	15,500	2.3	3.5	7.2
Napoleon	7,100	0.8	1.2	2.5
Bowling Green	16,000	1.3	2.2	5.6
Toledo	415,000	70	113	232

Self-Supplied Industrial Water

Toledo, Napoleon, and Lima are the major areas with large quantities of self-supplied industrial water. According to the census of all users estimated by the Ohio Division of Water in 1955, manufacturing plants used a total of 190 mgd, and power plants (municipally owned public utilities, and industrial) used a total of 642 mgd in the Ohio portion of the watershed, exclusive of Lake Erie. Heavy industrial use in the Toledo area amounts to a very high percentage of the total water used in the Basin. The Campbell Soup Company, which draws water from the Maumee River at Napoleon, Ohio, has severe water quality problems. In spite of extreme precautions taken by the Company for quality control of water used in the preparation of soups, batches of their finished product sometimes have to be discarded because of objectionable taste and odor.

Recreation

The Bureau of Outdoor Recreation (BOR) and the Bureau of Sport Fisheries and Wildlife, both of the Department of the Interior, have prepared reports concerning the recreational and fish and wildlife aspects of the Lake Erie Basin. The BOR has estimated that the annual pressure on the entire Lake Erie Basin as a whole is 245 million activity days for water-oriented and water-related recreation. The annual activity days for the Maumee River Basin was estimated by the BOR to be slightly

over 12 million. They also estimated that by 2020 both the Maumee Basin and the Lake Erie Basin as a whole should have a demand increase in summer activity days of over fivefold.

The principal water dependent recreational activities in the Basin are fishing, boating, swimming, canoeing, and water skiing. Those activities enhanced by water are camping, sight-seeing, hiking, and picnicking. Since the Maumee Basin is extremely flat and has little lake frontage, the recreational development has been largely along the rivers. The slack water of the rivers behind impoundments, the reservoirs at Lima, and Grand Lake, provide the main opportunity for boating. The Lower Maumee River at Toledo probably has the largest boat usage of the Basin as the boats may ply both the river and the Lake from this area. Many rivers in the Basin make excellent canoeing courses except during extreme low water periods. Figure 5-2 from the Ohio Department of Natural Resources, Division of Wildlife, shows the streams suitable for canoeing and power and sailboating if water quality and land ownership were not considered. Lake Erie, polluted along much of its shoreline between Detroit and Toledo and to the east of Toledo, offers little inducement for swimming.

Fishing is still an important recreational aspect of the Maumee Basin. In the past, fishing was probably the most important use as will be further discussed in Chapter 7 which contains a description of the historical water quality of the Basin. Several areas of the Basin now are almost completely devoid of fish, and no areas in any way approach the vast numbers of fish which used to be present. Figure 5-3, also from the Ohio Division of Wildlife, shows the stream sectors suitable for various types of fish if water quality was not a limiting factor.

Irrigation

According to the Ohio Division of Water report of 1955, over 1,500 acres are irrigated in the Ohio portion of the Maumee Basin. Almost half of this irrigated land is in the Bad Creek-Swan Creek-Tenmile Creek area. Crops irrigated are corn, potatoes, and other vegetables, as well as fruit, pastures, and nurseries. The total water withdrawal for farm field irrigation in Ohio in 1952 was 2.1 mgd distributed equally between surface and ground water supplies. Considerable portions of the soil in the Maumee River Basin are well adapted to irrigation if they are properly drained. Irrigation has shown a steady rise since 1950.

Irrigation is normally conducted only during extended dry periods in the summer or early fall, thus causing a water demand at the time when stream flow is normally the lowest. Although the total water used for irrigation is small, it is a consumptive use of water; therefore, the water is not returned to the streams but lost through evaporation.

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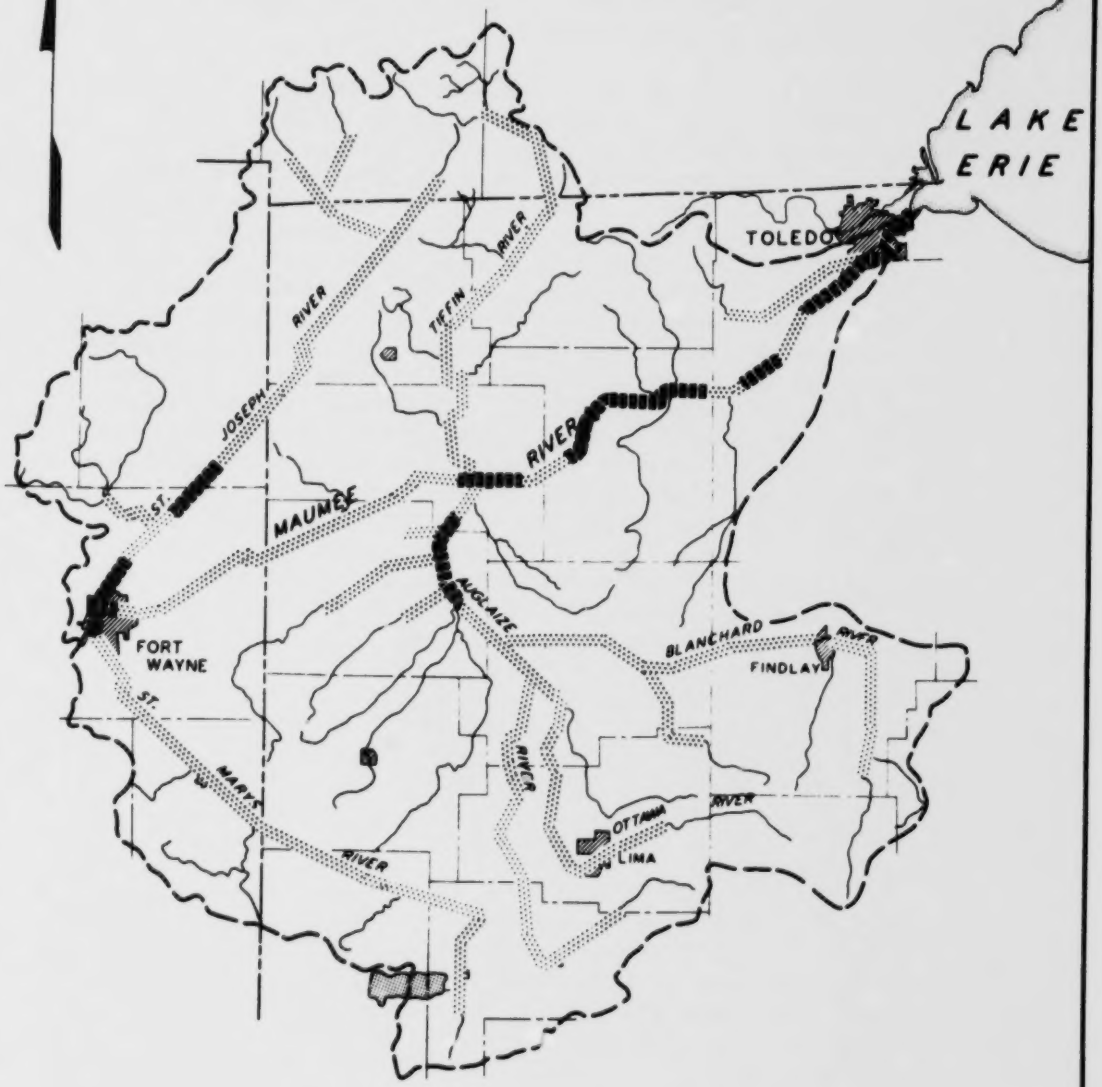


SCALE IN MILES

5 0 5 10 15 20 25

LEGEND

..... - CANOEING *

■■■■■■■■■ - POWER & SAIL BOATING AND CANOEING *

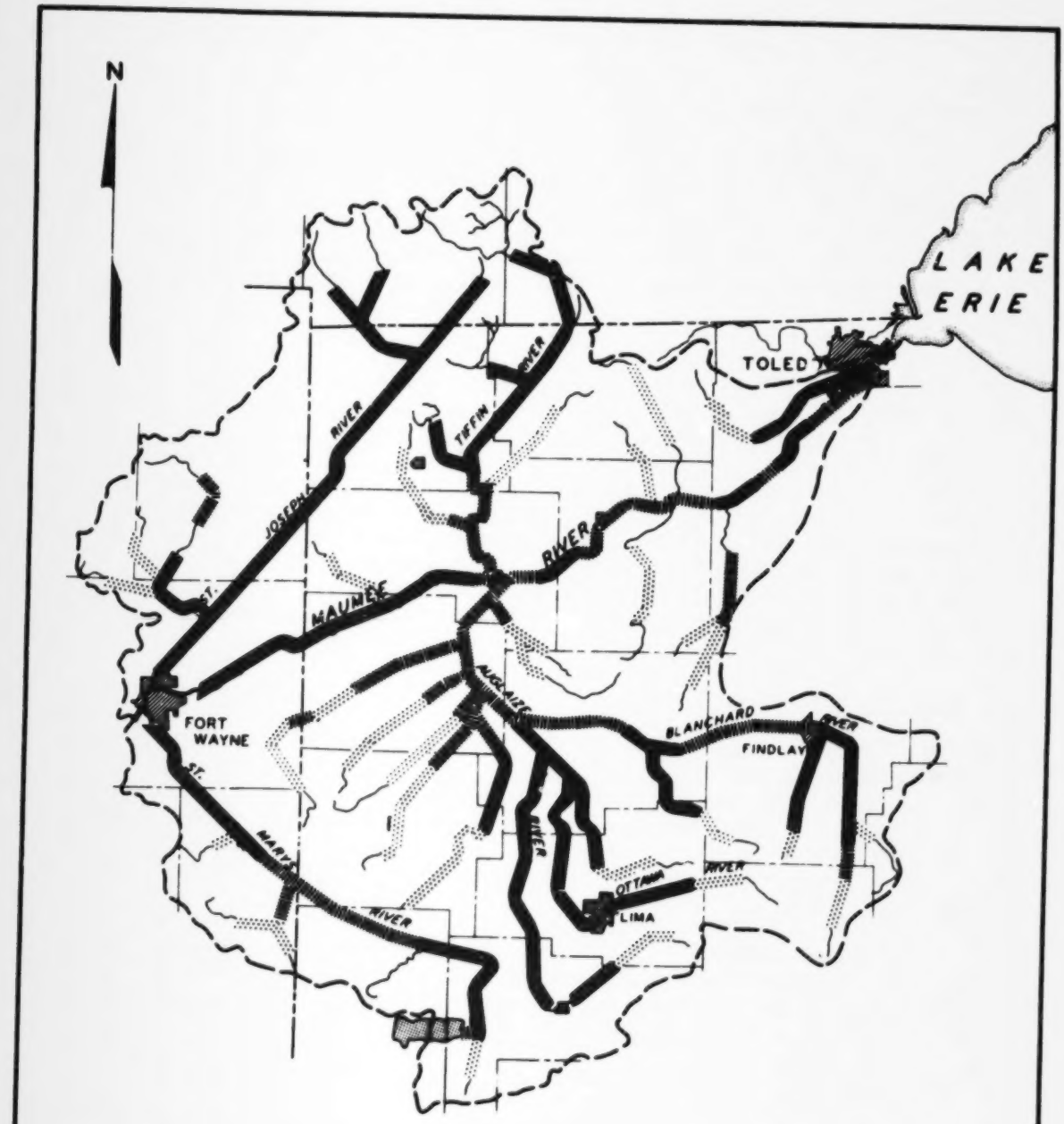
* IF WATER QUALITY AND LAND OWNERSHIP ARE NOT CONSIDERED.

THIS MAP WAS PREPARED FROM ORIGINAL MATERIAL PROVIDED BY THE OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WILDLIFE.

MAUMEE RIVER BASIN STREAMS SUITABLE FOR CANOEING AND BOATING

5-3-a

FIGURE 5-2



LEGEND

TYPE OF FISH*

- WELL-ROUNDED STREAM (SMALL MOUTH BASS, ROCK BASS, ETC.)
- WELL-ROUNDED POOL (LARGE MOUTH BASS, CRAPPIE, CATFISH, ETC.)
- BAIT

* IF WATER QUALITY IS NOT A LIMITING FACTOR.

THIS MAP WAS PREPARED FROM ORIGINAL MATERIAL PROVIDED BY THE OHIO DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WILDLIFE.

SCALE IN MILES

5 0 5 10 15 20 25

MAUMEE RIVER BASIN STREAMS SUITABLE FOR STREAM, POOL & BAIT FISH

5-3-b

FIGURE 5-3

Commercial Shipping

Commercial shipping is confined to the Toledo harbor area. Toledo harbor is one of the principal harbors of the Great Lakes. The principal cargoes handled through Toledo are coal, petroleum, iron ore, iron and steel, and grain. In the past ten years, the Toledo harbor has gone through an exceptional expansion period. The harbor is discussed in more detail in Section 4 of this report.

Fish and Aquatic Life

Most streams of the Basin do not provide good sport fishing due to their limited size, pollution from municipal and industrial waste, fluctuation of flow, land runoff and soil erosion. The Maumee River in the shallows downstream from the old canal feeder dams near Defiance and Grand Rapids was once an outstanding fishing spot for small mouth bass, rock bass, and channel catfish, according to the Ohio Division of Wildlife. These fish are almost totally absent now. The waters of the Maumee Basin are capable of supporting a wide variety of fish (Figure 5-3) and wildlife except for such cold water species as trout and steelhead. An historical discussion of the fish and aquatic life in the Basin will be given in Section 7.

Wildlife and Stock Watering

There are minor uses of the Basin's waterways for wildlife and stock watering, but the exact usage is not known. This particular water usage does not play a significant role in the water demands of the Basin. In some sectors it could have significant bearing on water quality requirements.

Waste Assimilation

Use of streams in the Maumee Basin for waste assimilation is one of the predominant present day uses, and in several locations it is the cause of extreme problems in water pollution control. These will be discussed in Chapters 6 and 7.

Esthetics

The use of water for esthetic enjoyment is an intangible benefit which is directly related to the availability of clean water. It is, nevertheless, a very important factor in determining the recreation potential of the area. Camping, picnicking, and sight-seeing, while not directly water-oriented activities, are considerably enhanced as an experience by esthetically pleasing water.

Streams can have great esthetic value for those who use parks and

parkway facilities. The previously mentioned parkway along the Auglaize and lower Maumee Rivers certainly may not be fully utilized until the streams have much of their pollution removed. Waters in which floating or suspended industrial and domestic wastes can be seen are neither attractive nor desirable. Besides the effect upon parks, these wastes also affect the value of adjacent land. Property values adjacent to clean water are significantly higher than those of similar properties situated next to a polluted stream. Since the lower Maumee and other areas will be called upon to provide recreation for many people, it is very important that these areas and the waters of the area be kept esthetically pleasing. It is also important, if not more important, that the area be attractive and remain so for those people who live there every day of the year.

CHAPTER 6

WASTE SOURCES

The following paragraphs summarize the major waste sources in the Maumee River Basin. The consequences of these discharges are described in Chapter 7. **Figure 6-1 is a diagram of the river system, showing water intake and waste discharge points.**

Municipal Wastes

Approximately 705,000 people are served by sewage plants in the Maumee Basin. These people would have a raw BOD_5* of approximately 183,000 lbs. If these wastes received either secondary or tertiary treatment, the discharges would total 18,000 and 5,500 lbs. per day respectively. Of the total 45 municipal sewage facilities in the Basin, 36 provide secondary biological waste treatment, 5 provide oxidation lagoons, 2 provide intermediate treatment, 2 provide primary treatment, and 11 provide minor treatment. Table 6-1 is a listing of the major Maumee River Basin municipal wastes for the present, 1980, and 2020.

Industrial Wastes

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Industrial wastes have a great effect on receiving waters in the Basin. Table 6-2 lists the major industrial wastes of the Maumee Basin. **This table is based mainly on information obtained from State water pollution control agencies, and has been reviewed by those agencies.**

Some of the industries listed in Table 6-2 have relatively small waste discharges, such as Excello in Lima, but at the place their outfall reaches the stream, the stream flow is quite small or non-existent for the majority of the year. Other industries, such as Standard Oil of Ohio in Lima, affect the quality of not only the Ottawa River, but the Maumee River down to its mouth. As with domestic wastes, a much higher degree of industrial waste treatment is required to produce acceptable conditions then if the wastes were discharged to a stream with a higher base flow of higher quality water. Many of the industries have spent vast sums of money in removing their pollutional materials from the streams, and most of them expect to continue spending money in the future to remove as high or higher percentages of their wastes.

Combined Sewers

Of the 16 areas listed in the study, 15 are of the combined or

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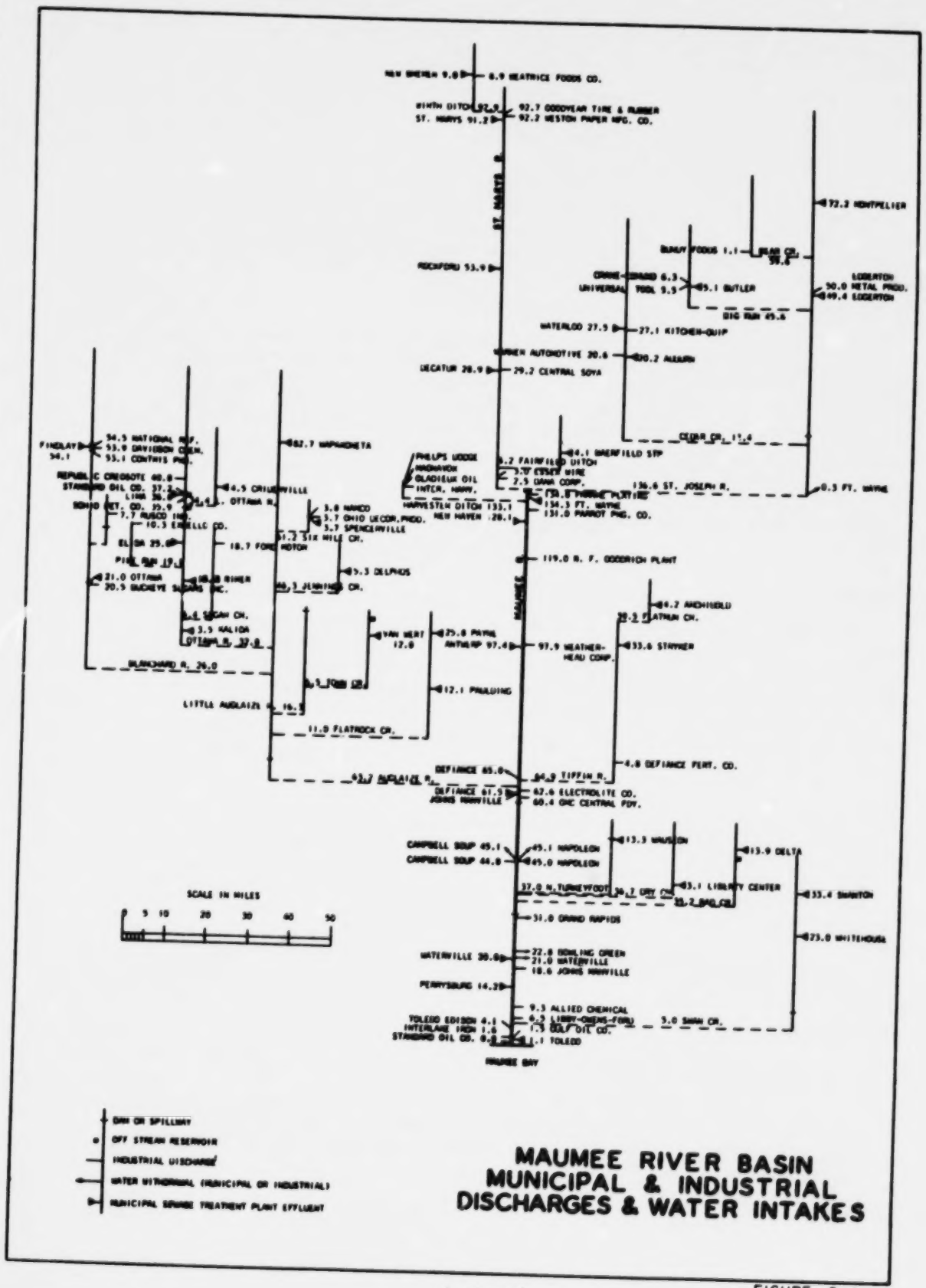
* As determined by the 5 day biochemical oxygen demand (BOD_5) analysis, 1 pound of BOD_5, is equivalent in oxygen-consuming capacity to a population equivalent of 6.



MAUMEE RIVER BASIN MUNICIPAL & INDUSTRIAL DISCHARGES & WATER INTAKES

6-1-a

FIGURE 6-1

TABLE 6-1

MAUMEE RIVER BASIN - MAJOR MUNICIPAL WASTES[1]
(BOD_5 in pounds per day)

City	1960 Population	1960 Raw	1960 Sec.Eff.[2]	1960 Tert.Eff.[3]	1980 Sec.Eff.[2]	1980 Tert.Eff.[3]	2020 Sec.Eff.[2]	2020 Tert.Eff.[3]
St. Joseph River								
Montpelier, O.	4,131	1,050	105	31	160	48	300	90
Butler, Ind.	2,176	370	37	11	50	15	80	24
Auburn, Ind.	6,350	1,080	108	32	140	42	230	69
Garrett, Ind.	4,364	740	74	22	100	30	160	48
St. Marys River								
St. Marys, O.	7,737	1,330	133	40	230	70	533	160
Berne, Ind.	2,644	450	45	13	70	21	150	45
Decatur, Ind.	8,327	1,420	142	43	210	63	460	138
Upper Maumee River								
Fort Wayne, Ind.	168,376[4]	46,100	4,610	1,380	8,200	2,460	21,890	6,570
New Haven, Ind.	3,396	580	58	17	100	30	220	66
Hicksville, O.	3,116	530	53	16	80	24	200	60
Defiance, O.	14,553	2,470	247	74	390	118	920	276
Tiffin River								
Hudson, Mich.	2,550	430	43	13	80	24	240	72
Morenci, Mich.	2,055	350	35	10	60	18	200	60
Archbold, O.	2,348	5,090	509	150	810	243	1,900	570
Bryan, O.	7,361	1,930	193	58	290	78	560	168

[1]Based on population predictions given in Figure 4-3
[2]Secondary treatment (90% removal)
[3]Tertiary treatment (97% removal)
[4]Includes population of Waynedale

TABLE 6-1 (continued)

MAUMEE RIVER BASIN - MAJOR MUNICIPAL WASTES[1]
(BOD_5 in pounds per day)

City	1960 Population	1960 Raw	1960 Sec.Eff.[2]	1960 Tert.Eff.[3]	1980 Sec.Eff.[2]	1980 Tert.Eff.[3]	2020 Sec.Eff.[2]	2020 Tert.Eff.[3]
Auglaize River								
Wapakoneta, O.	6,756	2,580	258	77	407	122	970	290
Spencerville, O.	2,061	280	28	8	50	15	130	39
Delphos, O.	6,961	1,320	132	40	230	69	630	189
Ada, O.	3,918	670	67	20	90	27	90	27
Lima, O.	53,537[5]	11,200	1,120	340	2,000	600	5,200	1,560
Columbus Grove, O.	2,104	1,470	147	44	220	66	420	126
Findlay, O.	30,344	7,700	770	230	1,270	380	3,000	900
Bluffton, O.	2,591	340	34	10	60	18	160	48
Ottawa, O.	3,245	550	55	16	79	24	155	46
Van Wert, O.	11,323	3,400	340	100	490	147	830	249
Paulding, O.	2,936	500	50	15	70	21	120	36
Lower Maumee River								
Napoleon, O.	6,739	1,150	115	34	170	51	330	99
Wauseon, O.	4,311	730	73	22	110	33	270	81
Delta, O.	2,376	560	56	17	90	27	210	63
Perrysburg, O.	5,519	790	79	24	140	42	380	114
Swanton, O.	2,306	440	44	13	70	21	160	48
Toledo, O.	318,003	85,060	8,510	2,550	14,600	4,380	30,300	9,090

[1]Based on population predictions given in Figure 4-3
[2]Secondary treatment (90% removal)
[3]Tertiary treatment (97% removal)
[5]Includes population of Westwood

TABLE 6-2
MAUMEE RIVER BASIN-INDUSTRIAL WASTES

Name of Industry	Mile Point	Flow in mgd	pH Range	Pounds per day (1) BOD	COD	Phenol	Oil	Solids (2)	Nitrogen (3)	Temp. °F	Other
Tenmile Creek											
Dana Corporation	x	x					x				
Driftmeyer Ditch											
E. I. Dupont	0.8	x		x	x		x	x			x
Otter Creek											
Standard Oil Co.(4)	0.4	39.8	6.9-9.1	8,810	x	670	11,800	184,000T 151,000D		78	
Gulf Oil Co.	1.5	68.4	7.3-8.6	4,600	8,200	110	1,260			x	
Sun Oil Co.	5.0	1.81	6.6-9.1	1,060	4,400	3	440	1,620S		x	
Lower Maumee River											
Interlake Steel Corp.	1.6	44.0	x	x	x	x	x	x		x	
Toledo Edison	4.1	x						x		x	
Libbey-Owens-Ford (East Toledo)	6.5	0.25					76	x			Color x

x Sufficient data not available for evaluation
(1) Where data were available, water intake stream loads were subtracted from effluent data
(2) Solids: T=Total Suspended and Dissolved, S=Total Suspended, and D=Total Dissolved
(3) Nitrogen: A=Ammonia, N=Nitrate, U=Urea, AE=Acetonitrile, and AY=Acrylonitrile
(4) Contains Pure Oil Co.'s effluent

TABLE 6-2 (continued)
MAUMEE RIVER BASIN--INDUSTRIAL WASTES

Name of Industry	Mile Point	Flow in mgd	pH Range	Pounds per day (1) BOD	COD	Phenol	Oil	Solids (2)	Nitrogen (3)	Temp. °F	Other
Lower Maumee River											
Allied Chemical	9.3		7.8		60						
Johns-Manville	18.6	54.0		380			x	6,900S			
Campbell Soups(5)	44.8	3.2		5,900			x			x	
Central Foundry-CMC	60.4	4.0		960	8,700	4	x			x	
Johns-Manville(6)	61.5										
S. K. Wayne Tools	62.6						x				
Weatherhead Corp.	97.9	0.28		33	31	x					CN 2.6
B. F. Goodrich	119.0	0.25		27	x		1			x	
Parrot Packing	131.0	0.09		884	730		136			x	

X Sufficient data not available for evaluation
(1) Where data were available, water intake stream loads were subtracted from effluent data
(2) Solids: T=Total Suspended and Dissolved, S=Total Suspended, and D=Total Dissolved
(3) Nitrogen: A=Ammonia, N=Nitrate, U=Urea, AE=Acetonitrile, and AY=Acrylonitrile
(5) Discharged in winter months only
(6) Unknown amount discharged to Defiance Sewage Treatment Plant

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TABLE 6-2
MAUMEE RIVER BASIN-INDUSTRIAL WASTES

Name of Industry	Mile Point	MGD	Pounds/Day BOD	Ammonia Nitrogen	Phenol	Oil	Cyanides	COD	Other
International Harvestor	133.1	x				x	x		
Magnavox Company	133.1				x				
Phelps Dodge	133.1	0.162	17.3		x			x	
Franke Plating	134.8	0.117	7.1		x	x	38.0	117	Zn 0.7 Cu 1.7 Ni 2.0 Cd 4.6
General Electric[2]									
Auglaize River									
Ohio Decorative Products	61.2	0.043	8.9			x		28.2	
Hays Industries	61.2	.105	6.4			x		35.9	
Blanchard River									
Buckeye Sugars Inc.	20.5	2.59	2160.0			x		x	
Rusco Inc.	30.6	.058	92.0		x	16.8	x	30.9	Mg 13.5 Si 36.8

[2] Unknown amount discharged to Fort Wayne Sewage Treatment Plant

6-1-9

TABLE 6-2

MAUMEE RIVER BASIN - INDUSTRIAL WASTES

Name of Industry	Mile Point	MGD	Pounds/Day						Other
			BOD	Ammonia Nitrogen	Phenol	Oil	Cyanides	COD	
Contris Packing	53.1	0.01	9		x		x	5.8	
Ashland Oil	54.5	0.64	35		1.1	480	x	1,780	
Ottawa River									
Ford Motor Co.	6.4	0.45	51			67		259	
Excello	40.0	0.12	16				x	34.2	
Standard Oil Co.	37.2	3.15	1900	x	80	881		x	Solids (1.000)
Republic Creosote	40.8	0.012	26		7.7	19	x	12.7	
Sohio Nitrogen	35.9	1.93	140	5,640				2960	Solids (33,600) CU (21)
Sohio Acrylonitrile	35.9	0.85	x	500				1970	Solids (13,400) CN (75)
Tiffin River									
Defiance Fertilizer Company	4.8			x				0.2	PO_4
St. Marys River									
Dana Corp. - Sal Axle Works	2.5	1.045	42			3.5	x	x	

6-1-7

TABLE 6-2

MAUMEE RIVER BASIN-INDUSTRIAL WASTES

Name of Industry	Mile Point	MGD	Pounds/Day						Other
			BOD	Ammonia Nitrogen	Phenol	Oil	Cyanides	COD	
Essex Wire	3.0	.088	2.1		x				
Central Soya Co.	29.2	.053	4.3		x		x	x	
Weston Paper Mfg. Company	92.2	x	x			x		x	
Goodyear Tire & Rubber Co.	92.7	1.10	344				x	448	
Beatrice Foods Co.	92.7	0.08	15			x		59	
St. Joseph River									
Warner Automotive	13.4	0.389	4.7		x	x	x	x	
Kitchen-Quip	13.4	0.141	12.1		x	x	0.01		Zn 1.5 Cu 0.9 Ni 7.2
Crane-Edmund	45.6	0.064	3.9		x	17.1	1.30	49.5	Zn 3.9
Universal Tool[3]	45.6	0.025	4.4		x	19.2	3.3	7.9	Zn 4.0
Edgerton Metal Products	50.0	0.144	14.5				2.0	42.2	Cr 0.1 CN 0.1
Bundy Foods	59.6	0.108	5.5			x		15.8	

[3] Unknown amount discharged to Butler Sewage Treatment Plant

combined-separated type and one is not sewered. The majority of the Basin's sewerage systems are of the combined type. (Table 6-3)

Problems relating to overflows from combined sewer systems are complex and have been quite well documented in the past. Even if all domestic wastes were given tertiary treatment, the problem would not be solved until a number of the combined sewers are removed **or overflows combined.**

TABLE 6-3

MAJOR COMMUNITY SEWER SYSTEMS

Community	Type of System
Auburn	Combined
Bryan	Combined
Defiance	Separate - combined
Decatur	Combined
Delphos	Combined
Findlay	Separate - combined
Fort Wayne	Combined
Lima	Separate - combined
Napoleon	Separate - combined
Perrysburg	Combined
St. Marys	Separate
Sylvania	Separate
Toledo	Separate - combined
Trilby	Not sewered
Van Wert	Separate - combined
Wapakoneta	Separate - combined

Solid Wastes

There are several areas in which the Basin's waterways are used for the disposal of solid wastes. An example of interstate pollution in this respect is Willshire, Ohio which has a large dump along the St. Marys River just above the Indiana line. Disposal of garbage, trash, and other deleterious refuse in the Maumee River and its tributaries should be prohibited and existing dumps along the river banks should be removed.

Agriculture and Land Runoff

One of the long-term major sources of pollution in the Maumee River is agriculture. Even if all domestic and industrial wastes were

removed from the Basin, there would still be significant water pollutional problems present. The primary pollutants from agriculture are nutrients and sediment, with secondary materials of herbicides, fungicides, pesticides, and algicides.

An example of nutrient pollution from agriculture is Burr Lake on the Little Auglaize River where secchi disc (transparency) readings of 3 inches were commonly obtained. Another example is Van Buren Lake in which, when the temperature is above 55°F, the secchi disc readings average around 6 inches due to the colloidal material present.

Trautman (1957) has described how particular agricultural practices have deteriorated the water quality in the Maumee Basin. The only soil conservation practices instituted in the Basin seem to be drainage works. The idea appears to be to get the water off the land as quickly as possible, regardless of other considerations.

The Maumee River has the highest sediment concentration of any river in the State of Ohio. During the years 1951 to 1957 the Maumee River discharged an average suspended sediment load of over 1.4 million tons per year to Lake Erie. Biologists believe that these heavy silt loads from the Maumee River have smothered the spawning beds of the white fish in Western Lake Erie and hastened the decline of the Lake Erie fishery. The difficulty with much of the sediment from this area is its extremely small particle size, in many cases approaching almost a colloidal diameter. During low flows, over 80 percent of the sediment has a particle diameter less than 2 microns and over 90 percent has a diameter less than 4 microns. (A micron is 1/25,000th of an inch.) Thus, besides having the greatest total amount of sediment load, the Maumee River also contains the finest sediment.

To make a preliminary estimate of the chemical constituents in the rural runoff in the Maumee River watershed, results of data obtained in the Lake Michigan small rural watershed sampling program were used. This information with knowledge obtained from field observations in the Maumee Basin was utilized to make the final determination. Table 6-4 is a listing of the preliminary estimates of the chemical constituents for the rural runoff expressed in 100 tons per year for the various subbasins.

The object of drainage is not to get water off the field as quickly as possible on the surface, but to drain the land through subsurface tile drains in combination with contour farming. The crops of some parts of the Basin may have to be changed since beans and corn leave the land denuded in the wintertime. Strips of hay and grasses may be needed to help prevent erosion. Strip or contour farming may be needed in some almost flat areas to help prevent sheet erosion.

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TABLE 6-4

ESTIMATED CHEMICAL CONSTITUENTS OF RURAL RUNOFF*
(in 100 tons per year)

	Auglaize	Upper Maumee	Lower Maumee	St. Joseph	St. Marys	Tiffin
Ammonia	.9	.1	.4	1.2	.3	.5
Organic Nitrogen	1.6	.4	.6	1.2	.3	.9
Nitrate	1.5	.3	.7	2.7	.5	1.0
Total Nitrogen	3.6	.6	1.5	5	1.1	2.1
Phosphate	0.5	.1	.2	1.4	.2	.5
Sodium	18	3.8	6	41	3.9	15
Silicate	34	9	10	37	4.9	20
Potassium	7	.8	3.4	8	2.8	29
Sulfate	65	4.4	37	200	32	55
Chloride	20	2.1	11	65	9	18
Magnesium	70	9	35	90	29	34
Calcium	145	27	55	300	39	105

* Runoff Quality by Soil Groups and General Land Use -- A preliminary estimate -- made by extrapolation of data from the Lake Michigan Watershed (GLIRER Rural Runoff Studies) and field observations made of the Maumee River Basin. Values for solids are omitted since no correlation has been established.

After oxygen deficits and sediment, algae are probably the next major problem in the Basin. In many areas of the Basin, the expression "Too thick to drink, too thin to plow" is quite applicable in relation to algae. Algae of the green or blue-green types are present the year around throughout almost all of the Basin. Besides the taste and odor problems they cause in domestic drinking waters and commercial canning, they interfere with the recreation and esthetic uses of the waters.

Federal Installations

There are 43 Federal installations in the Basin. Of these, 37 discharge their wastes to municipalities providing secondary treatment and 4 discharge to municipalities providing primary treatment. The other two Federally-owned or Federally-leased installations listed below discharge waterborne wastes in the Maumee River Basin area. Installations that discharge to municipally-operated sewerage systems have not been listed since the Federal Government does not control the treatment provided.

GPO 827-431-8

1. The New Haven Defense Materials Supply Depot discharges 2,000 gpd to the ground. The waste treatment facilities operate satisfactorily and appear adequate at this installation.

2. The U. S. Coast Guard's Toledo Harbor Light Station presently discharges some 350 gpd of sewage to the harbor. The station will be completely automated by September 1, 1966, thus ending the discharge of raw sewage.

Vessel Wastes

The vessels plying the waters of the Maumee Basin represent a potential source of pollution to the streams and to the harbor. The possible sources of pollution in the harbor area include cargo spillage, dunnage, ballast and bilge waters, fuel spills, garbage, and sanitary wastes. Uncontrolled discharge of these wastes can result in serious pollution problems for beaches, shore property, recreational waters, fish and aquatic life, and municipal and industrial water supplies. In the upstream slack waters where pleasure boating exists, domestic waste may be discharged to the waters from boats.

The U. S. Public Health Service has established regulations governing vessel waste discharges in the Great Lakes based upon its legal responsibility for the interstate control of communicable diseases. Restricted areas have been established in which the discharge of sewage, ballast, or bilge water from vessels is prohibited. Restricted areas include the water within a three-mile radius of domestic water intakes.

Dredging

Legislation passed in 1962 provided for the present maintained depth of 25 feet in Toledo Harbor to accommodate deep draft vessels using the St. Lawrence Seaway.

All maintenance dredging of the harbor is done by the Corps with their own boats. This past year they dredged almost one million cubic yeards of materials from the Maumee River channel. This material,as a whole, was composed of about 80 percent silt and 20 percent sand, with a higher content of silt in the river and sand off-shore. Only a small percentage of the materials appear to be from industrial sources. The majority of the sediment is from river bank and land sheet erosion and off-shore transport.

All materials dredged in the river and out to channel buoy 30 (about four miles into the bay from the mouth) are discharged either to a large diked area just north of the mouth, or to two temporary private areas at River-side Park. The materials dredged from buoy 30 out are discharged to an area off the Erie Ordance Depot and Proving Grounds.

CHAPTER 7

WATER QUALITY PROBLEMS

The information and interpretations presented in this discussion are based on water quality data collected by the Lake Erie Program Office during its water quality studies of the Lake Erie Basin (1963-1966). These studies have been supplemented by data obtained from the States of Indiana, Michigan, and Ohio, and regional and local agencies.

General

Biology

The kinds and numbers of aquatic plants and animals inhabiting a particular body of water and the stream or lake bottom beneath it, reflect the quality of water that has generally prevailed in the area for an extended period of time. Some plants and animals, by virtue of their physiological features or living habits, are capable of withstanding polluted conditions. They multiply rapidly when competition with less tolerant forms is eliminated. Examples of pollution-tolerant animals are sludgeworms, bloodworms, leeches, and pulmonate snails. These animals exist in the decaying organic sediment which builds up from the settleable organic solids present in most waste discharges. A benthic (bottom dwelling) population consisting of many kinds of organisms with low numbers of each species is typical of unpolluted waters. The relative scarcities of pollution-sensitive organisms, usually scuds, and the concomitant abundance of pollution-tolerant forms, usually sludgeworms, are considered reasonable indicators of stream areas subjected to organic enrichment and/or pollution if all other conditions are favorable.

Planktonic algae are microscopic, chlorophyll-bearing plants suspended in the water. The density of algae in the water is dependent upon several factors, including the concentration of nutrients. All other factors being favorable, the higher the concentration of nutrients, the greater will be the density of algal growth. To a degree, they also indicate the quality of the water in that the kinds and numbers of algae present depend on the chemical and physical composition of the water in which they originated and in which they live.

Microbiology

The kinds and numbers of bacteria found in a given volume of water provide valuable information with respect to the sources of contamination likely to render the waters unfit for certain uses--particularly water

supply and recreation. **Total coliforms,fecal coliforms,and fecal streptococci** indicate the likely presence of wastes of human or animal fecal origin. These organisms are associated with pathogenic organisms such as typhoid, paratyphoid, salmonellae, and enteric parasites. Generally, the higher the concentration of coliform or streptococci, the greater the chance that enteric pathogens will be present and the greater the threat to the health of those exposed to or consuming such waters.

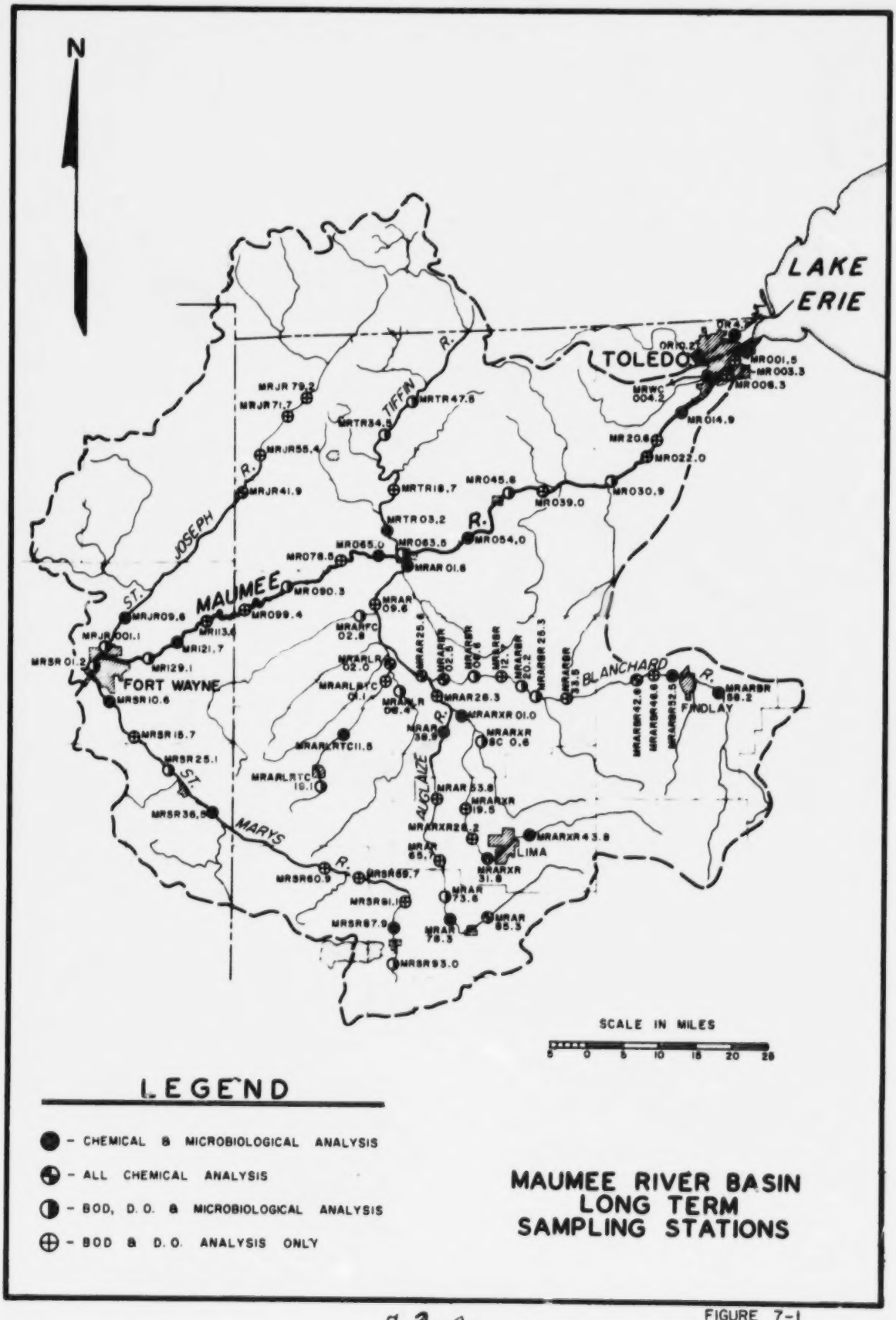
Parameter Results

Figure 7-1 lists the long-term chemical, microbiological, and biological sampling stations. Figures 7-2 through 7-9 graphically depict a number of the significant chemical and microbiological parameters. These figures indicate many of the water quality problem areas and should be referred to while reading this chapter. The fold out map at the back of this report should be used to locate a specific city or area in reference to these figures.

Water Quality Evolution

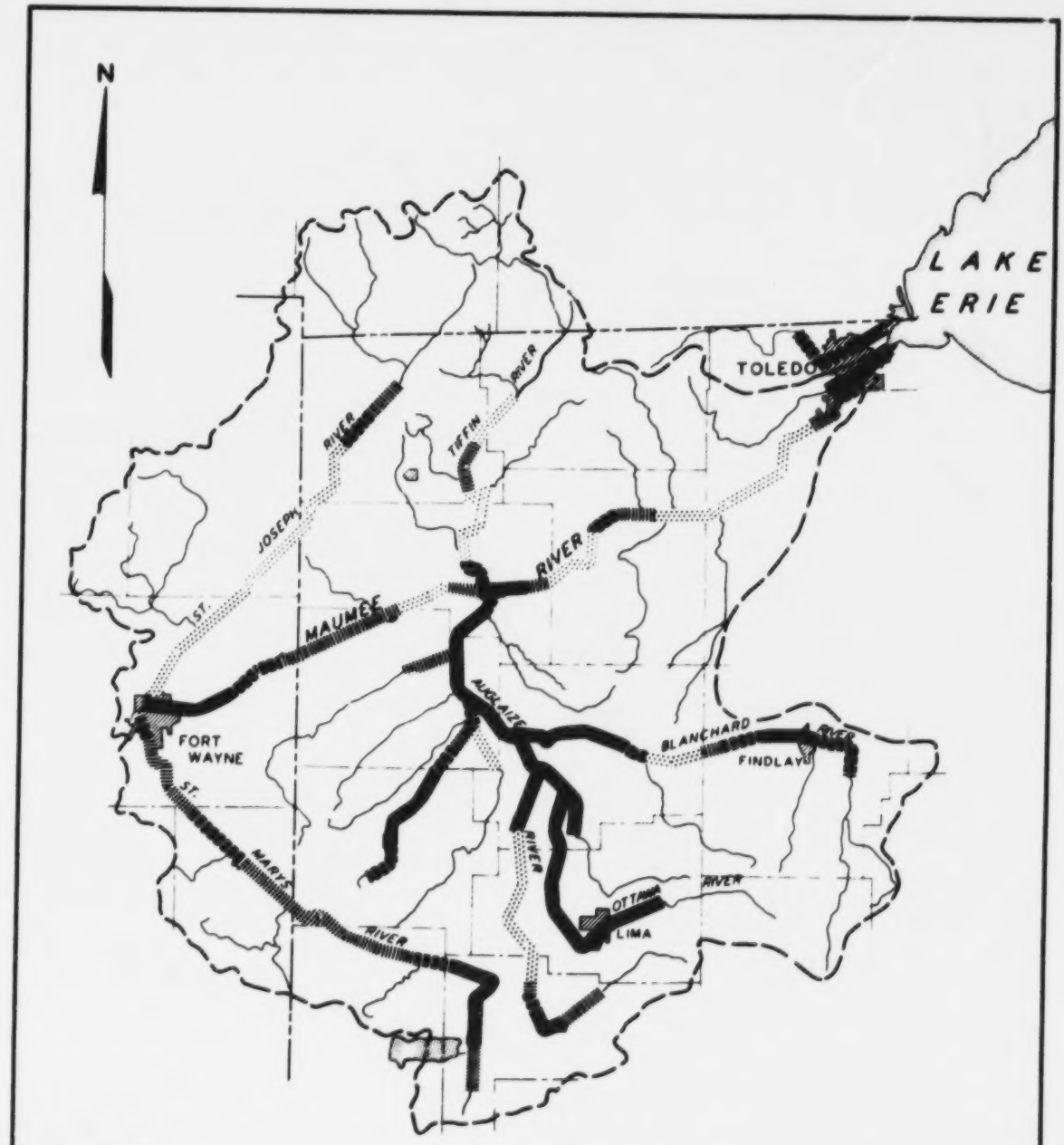
Prior to 1800, historical references regarding conditions of streams in the Maumee River Basin indicate that the waters were normally clear; soil erosion was slight; and stream bottoms were composed of sand, gravel, boulders, bedrock, and organic silt. Aquatic vegetation flourished in unshaded areas of the waters, but where trees or foliage covered a stream, little aquatic vegetation prevailed. References regarding enormous fish populations, both larger food fishes as well as the smaller fine fishes, indicate that the waters and sediments of these streams were conducive to excellent clean water aquatic life.

Since 1800, the increasing population, with its industry, farming, dams, mills, slaughter houses, breweries, and cities, was the major factor which influenced the accelerated degradation of the water quality in the Maumee River Basin. Ditching, dredging, and tilling of the marshlands surrounding this area allowed accelerated erosion of the soils. Soil, dams, and pollutants adversely affected the aquatic vegetation. Troutman (1957) observed a decrease in the amount or elimination of rooted aquatic vegetation between 1901-1930.[12] Consequently, desirable fish disappeared and a more tolerant species became prevalent. Continuing sedimentation from the Maumee and other southwestern tributaries has affected the western end of Lake Erie drastically. The gravel and bedrock reefs of western Lake Erie that were spawning grounds for Whitefish and Cisco are now silted over. It is quite likely that sedimentation from eroding soils was the most detrimental and the most universal of all pollutants.



7-2-a

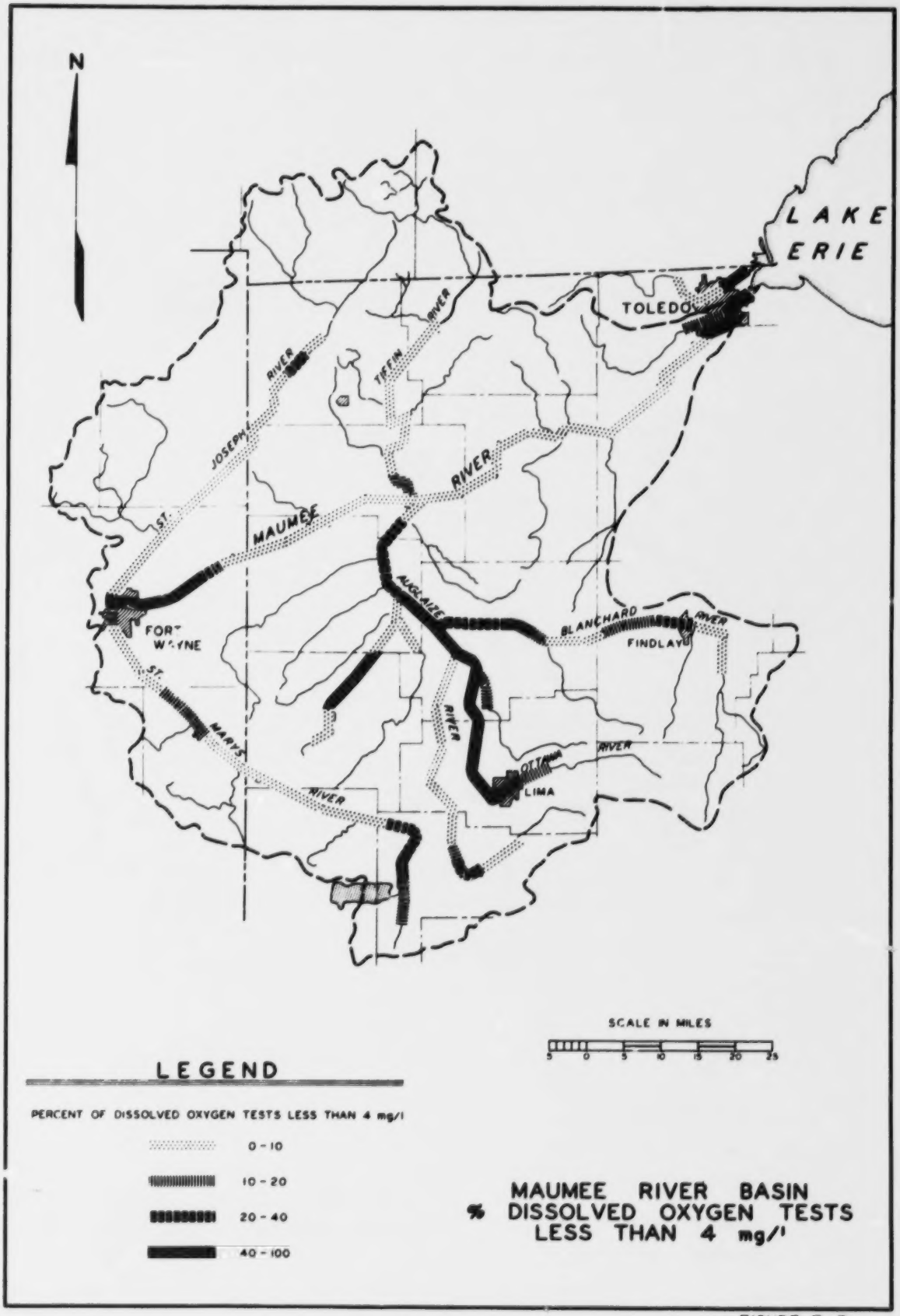
FIGURE 7-1



MAUMEE RIVER BASIN
MINIMUM DISSOLVED
OXYGEN CONCENTRATION

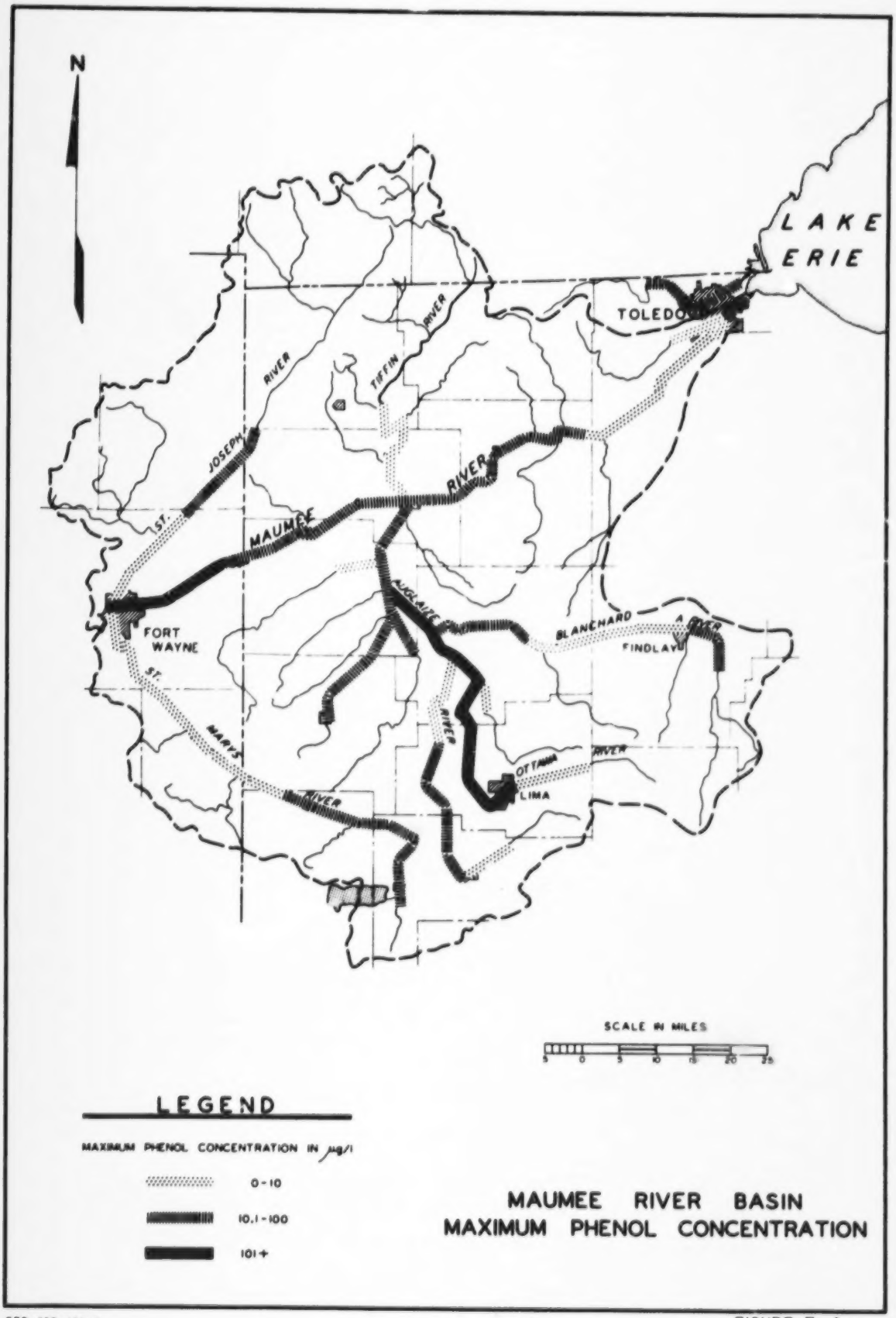
7-2.b

FIGURE 7-2



7-2-c

FIGURE 7-3

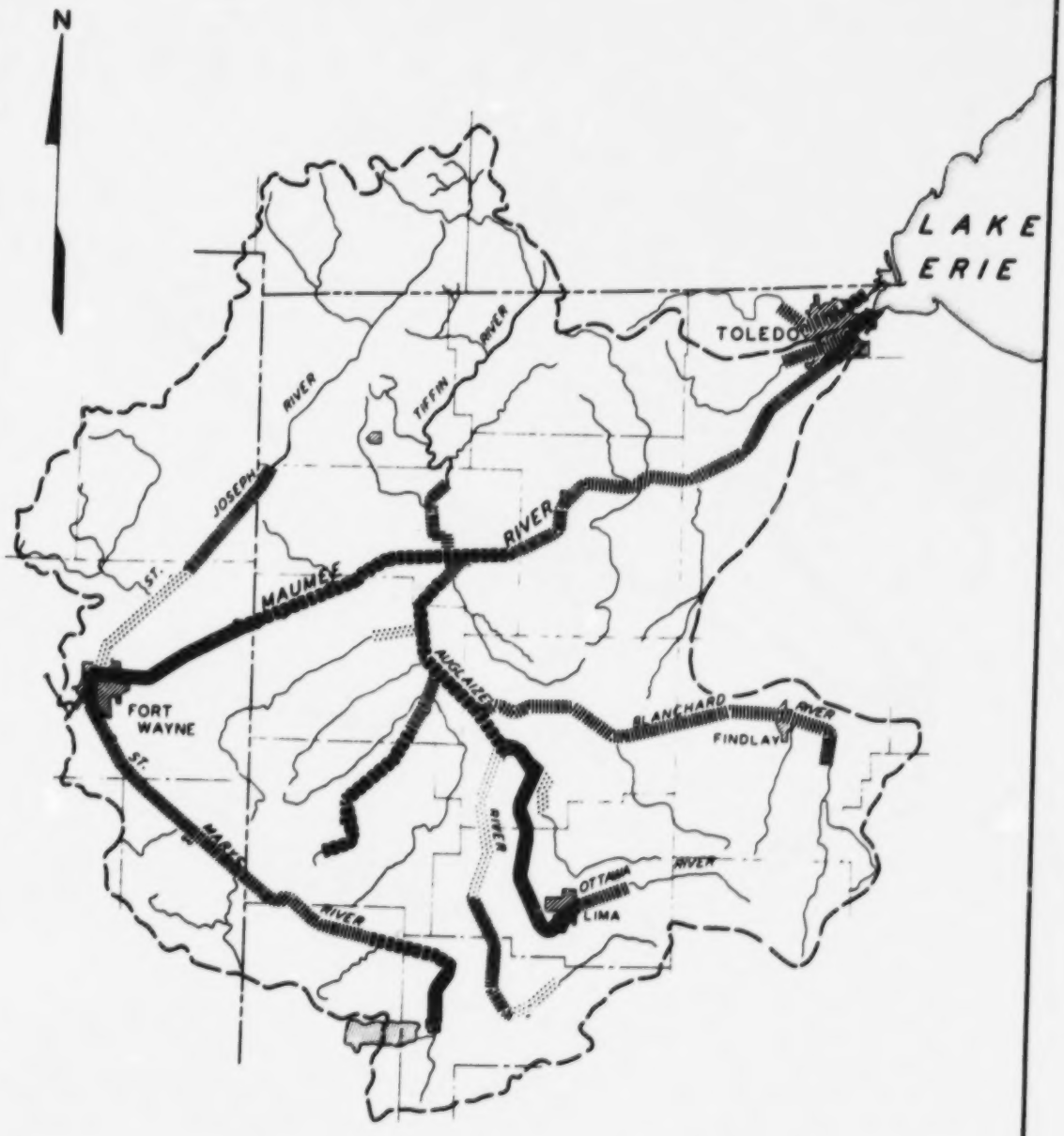


MAUMEE RIVER BASIN
MAXIMUM PHENOL CONCENTRATION

GPO 827-431-7

7-2-d

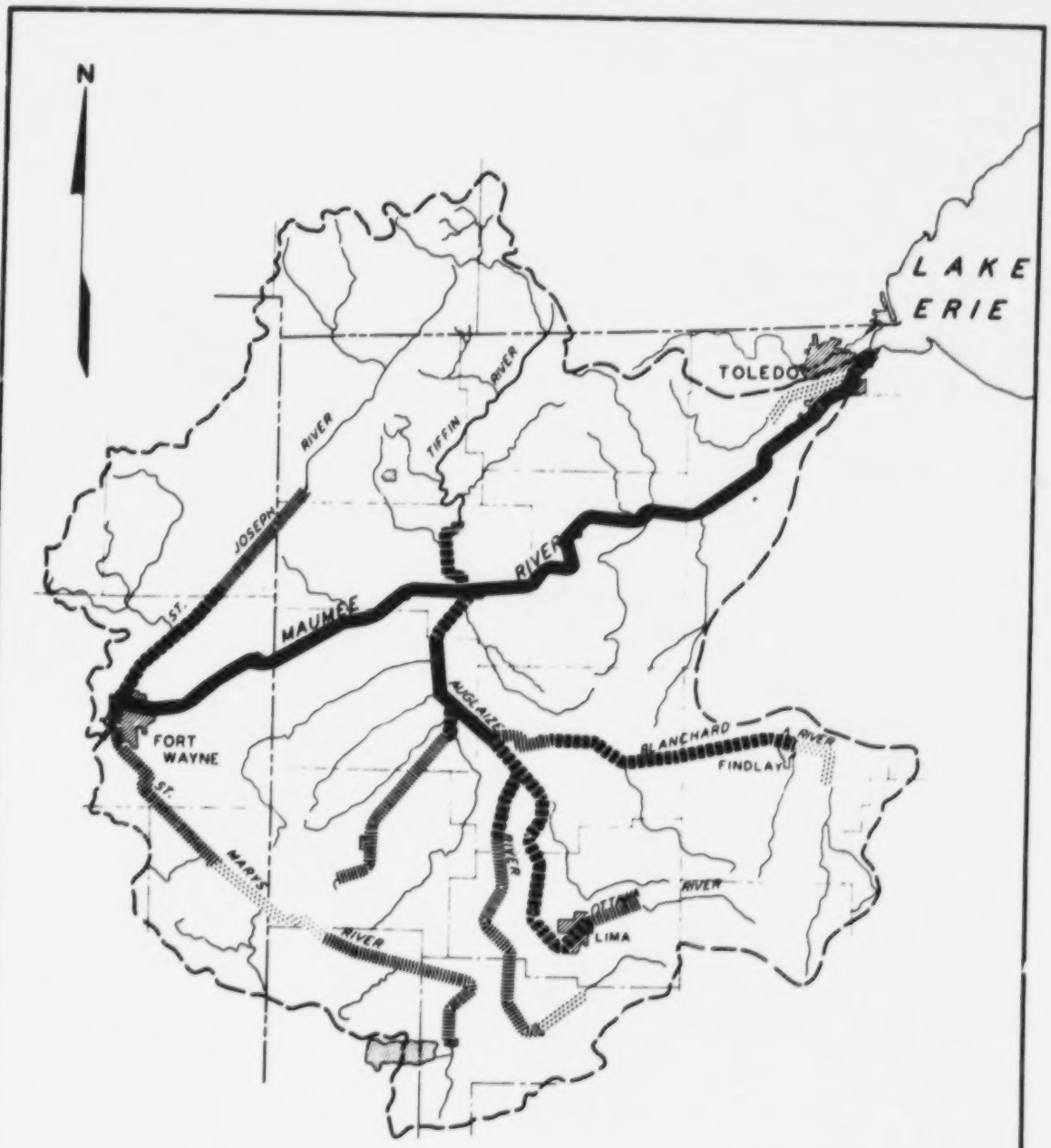
FIGURE 7-4



MAUMEE RIVER BASIN
AVERAGE PHENOL CONCENTRATION

7-2-e

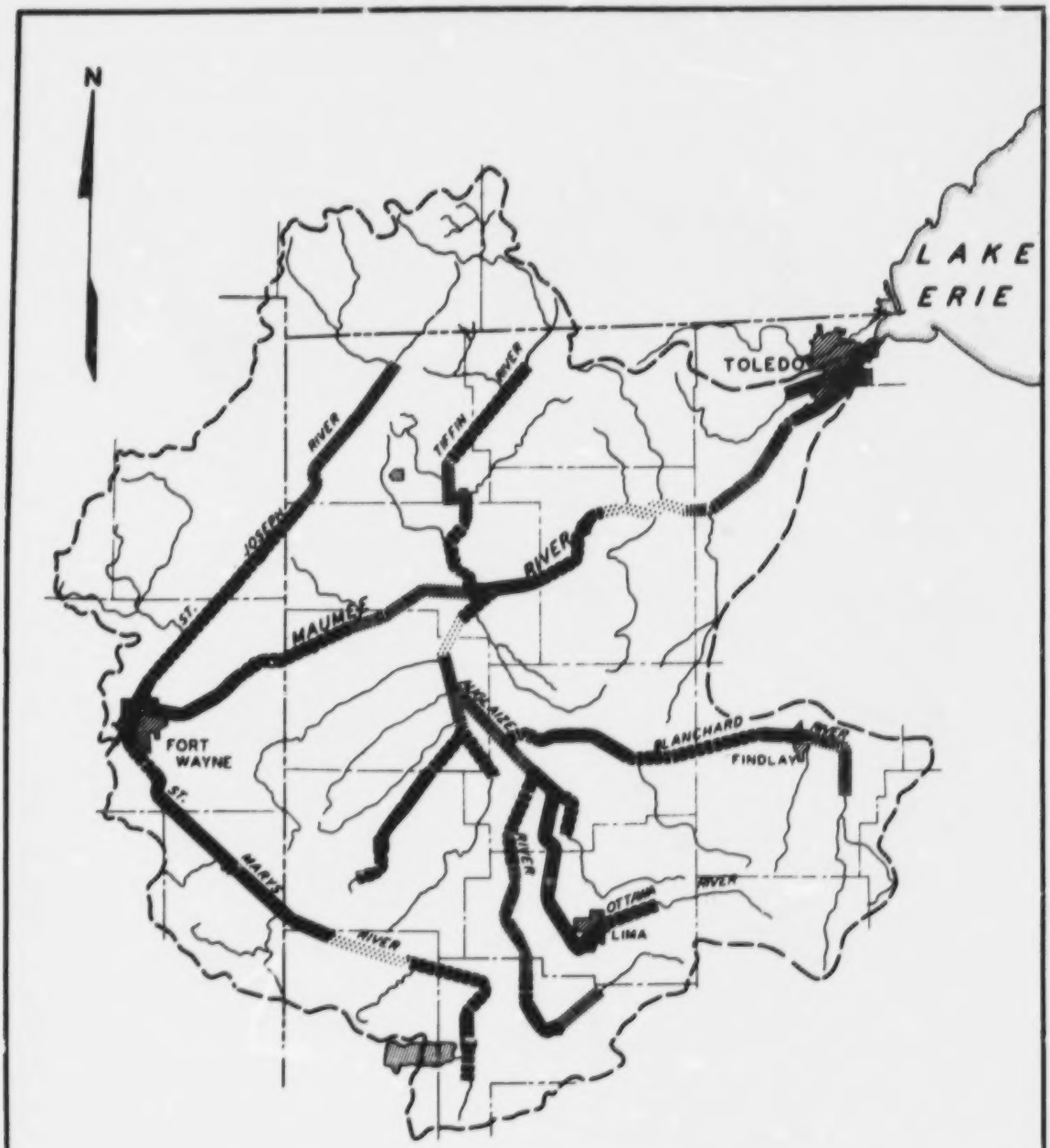
FIGURE 7-5



MAUMEE RIVER BASIN
AVERAGE SOLUBLE PHOSPHATE LOAD

7-2-f

FIGURE 7-6



LEGEND

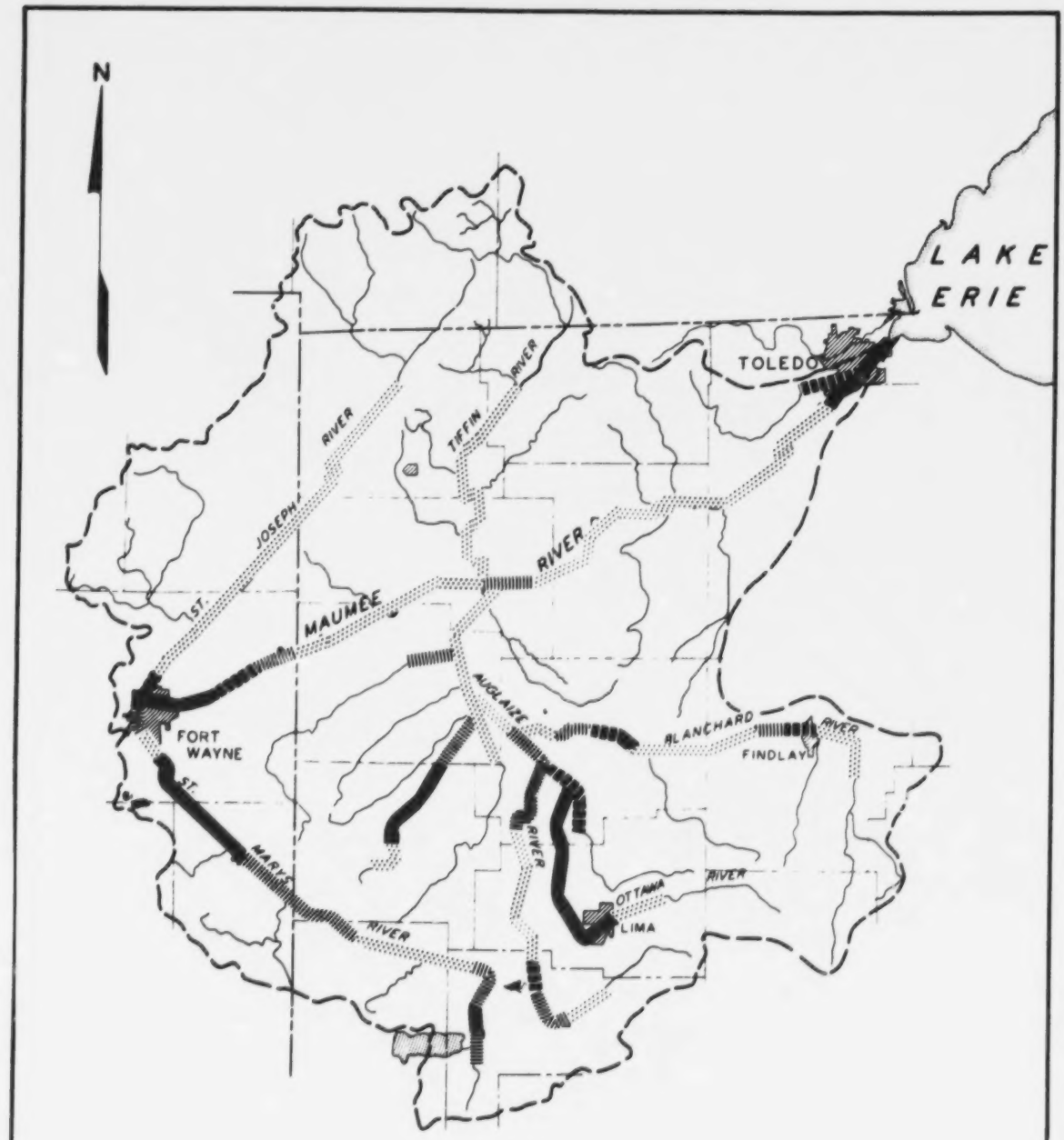
MEDIAN TOTAL COLIFORM CONCENTRATION IN ORGANISMS PER 100 ml.

- 0 - 1,000
- 1,000 - 2,400
- 2,400 - 10,000
- 10,000+

MAUMEE RIVER BASIN MEDIAN TOTAL COLIFORM CONCENTRATION

7-2-g

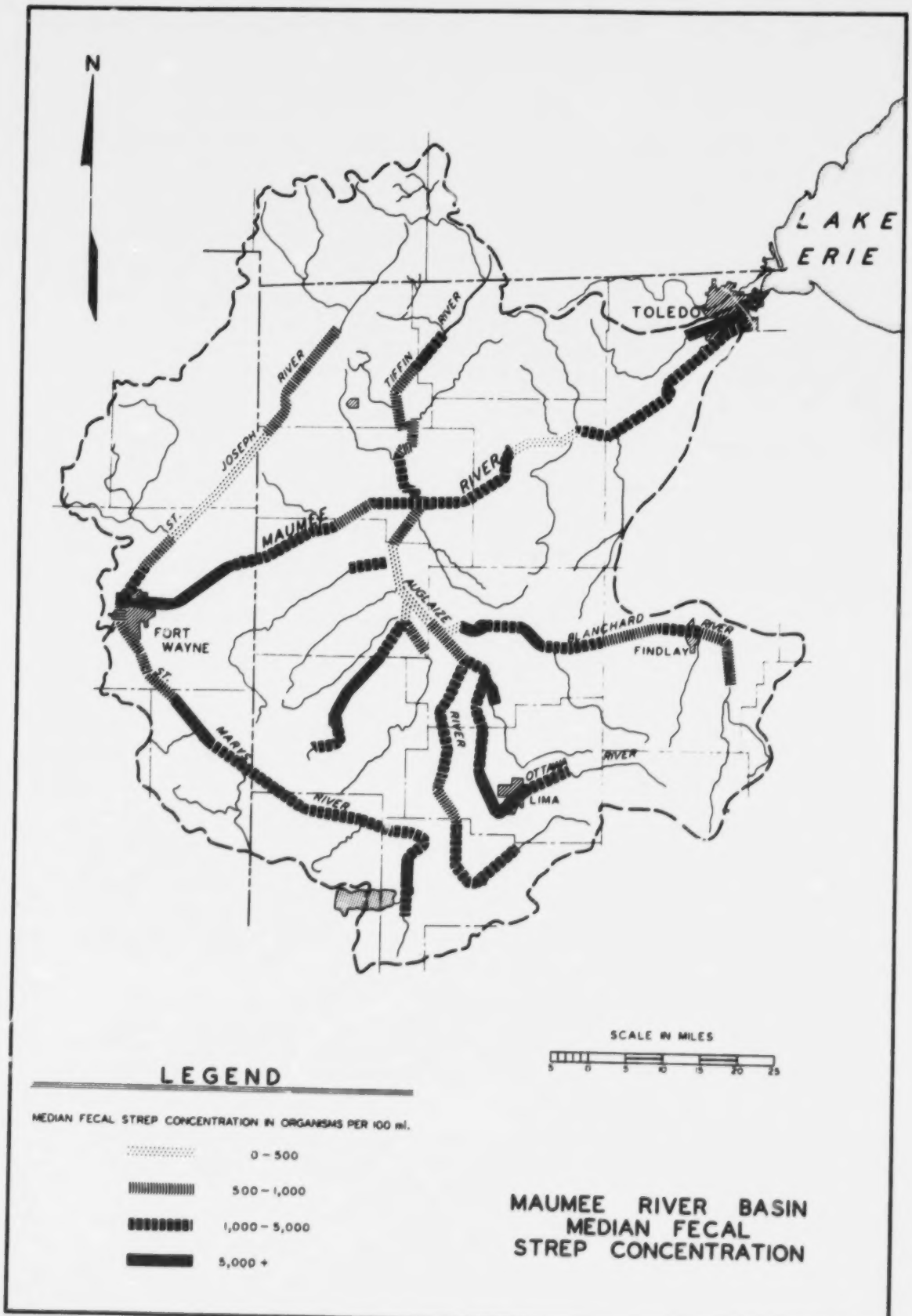
FIGURE 7-7



MAUMEE RIVER BASIN
MEDIAN FECAL
COLIFORM CONCENTRATION

7-2-h

FIGURE 7-8



7-2-i

FIGURE 7-9

St. Joseph River

The overall water quality of the St. Joseph River above Montpelier, Ohio is good. The Montpelier sewage treatment plant effluent has a biological oxygen demand (BOD) of 796 pounds per day. Below this point, the concentration of dissolved oxygen (DO) falls to an average of 4 mg/l during low flow. A minimum DO concentration of 2 mg/l was recorded several times during late summer. The flow of the stream during the sampling period at this point was 17 cfs or less, 18 percent of the year. Biological conditions typical of gross pollution existed during these low flows. The stream bottom is silt, mud, and detritus. An oily sludge was observed during low flow conditions. Bottom dwelling animals were limited to the pollution-tolerant sludgeworms and midge larvae.

St. Marys River

The overall water quality of the St. Marys River is fair. Abundant growth of algae occur throughout the entire year. The main sources of pollution in this subbasin are agricultural and domestic.

A dissolved oxygen sag occurs on the St. Marys River below the City of St. Marys. This sag is caused by the discharges of the St. Marys sewage treatment plant, Goodyear Tire and Rubber Company, Beatrice Foods Company, and Weston Paper Manufacturing Company. The DO at this point was below 1 mg/l over fifty percent of the time sampled.

During the period October-December, 1964, the median coliform densities in this area were 540,000 organisms per 100 ml with a range of 10,000-2,900,000. The maximum fecal streptococci density recorded was 155,000 organisms per 100 ml.

Biological sampling in the early spring of 1964 disclosed a sparse population of pollution-tolerant midge larvae and sludgeworms. The stream bottom was sand, rubble, and rock, and no sludge deposits were found. By July, a black septic sludge had accumulated over the stream bottom and emitted a strong septic odor. Because of severe environmental conditions, no bottom-dwelling organisms were found during the summer or fall surveys.

An example of interstate pollution by solid wastes occurs at Willshire, Ohio where the city has a large dump along the St. Marys River just above the Indiana line. This dump, as can be seen in Figure 2-2D, spills garbage, trash, and other deleterious refuse into the St. Marys River.

Another dissolved oxygen sag occurs downstream from Decatur, Indiana. For several miles below Decatur the dissolved oxygen was

below 4 mg/l for 20 percent of the samples. The majority of the oxygen demand load in this area is from Decatur's secondary treatment plant. Although the BOD loading from the plant is relatively low, the river cannot accommodate these loads during the low flow months. The principal industry, Central Soya, may well serve as a model for many industries and cities in the Maumee Basin, in that at this time they provide the equivalent of tertiary treatment through the use of oxidation ponds. The only additional treatment that might be required of Central Soya would be some form of phosphate removal.

Upper Maumee River

The Upper Maumee River varies in water quality from extensively polluted in the upper reaches below Fort Wayne to normally unpolluted above the Defiance area. In the upper reaches the biological conditions are seriously degraded. The stream bottom has heavy deposits of oily organic sludge and supports only a sparse population of pollution-tolerant sludgeworms and midge larva.

High concentrations of phenols occur below Fort Wayne, with a maximum concentration of 137 micograms per liter (mg/l) recorded at the station 12.6 miles below the Fort Wayne Sewage Treatment Plant. The average phenol concentration at this station was 24 mg/l for the year sampled. In warm weather the phenols in the Upper Maumee are readily broken down by the self-purification processes in the receiving stream. But in winter months, when the water temperature is reduced to near freezing, phenols may persist for many miles downstream. Under these conditions the phenols discharged in the Fort Wayne area cause extensive taste and odor problems in the City of Defiance's water supply. Phenol concentrations in excess of 50 mg/l have been recorded in the winter time above Defiance. There are no known sources except the Fort Wayne area to account for these high readings.

In an area below Fort Wayne the geometric mean values of total coliform, fecal coliform, and fecal streptococci were 210,000, 12,000; and 8,000 respectively. These high values result from a combination of Fort Wayne's treatment plant effluent and the discharge from the numerous suburban septic tanks in and above the Fort Wayne area.

A dissolved oxygen (DO) sag occurs in this area below Fort Wayne. At milepoint 129.1 (7.0 miles below the confluence of the St. Mary's and St. Joseph Rivers) the DO was below 4 mg/l over 60 percent of the times sampled. Seven miles farther downstream the DO was still below 4 mg/l over 50 percent of the times sampled throughout the year. From milepoint 113.6 downstream the stream had recovered and the DO was below 4 mg/l less than 10 percent of the time.

In the nutrient-rich waters of the Upper Maumee extensive phytoplankton populations occur, with counts in excess of 30,000 per ml. In this area algal photosynthesis is the most important factor affecting the DO. At Antwerp, diurnal DO studies showed ranges of 3.8 to 8.2 mg/l and

10.3 to 20.0 mg/l on two 24-hour studies in July (Figure 7-10). Palmer (1963) indicates that there are certain genera of planktons that persist in polluted streams. According to his table of genera, 95 percent of the genera found in the Maumee River are of the pollution tolerant type (63). Increasing numbers of blue-green and green planktons which are associated with taste and odor problems, have been recorded in the Basin. These or related planktons also exist in the wintertime even under an ice cover. The average soluble phosphate content in the river dropped from over 3.6 mg/l near Fort Wayne to just over 0.5 mg/l above Defiance indicating that it had been incorporated in the organic chain. The presence of relatively intolerant bottom-dwelling animals in the Antwerp area indicates that prolonged periods of low DO do not occur in this vicinity.

Tiffin River

The overall water quality in the Tiffin River is generally quite good throughout its entire length except in several of the lower parts where it is mildly polluted. The highest coliform densities recorded rarely exceeded 5,000 per 100 ml, and these occurred in the Stryker and Defiance areas. Excluding the last four miles of the Tiffin River, the DO never went below 3.5 during the time the river was sampled.

Auglaize River Basin

The water quality in the Auglaize River Basin, and particularly in its tributary, the Ottawa River, is the lowest in the Maumee River Basin. Above the cities and industries the water is of good quality, but below many of them, the water is unfit for any use.

Ottawa River

The Ottawa River is grossly polluted--the worst in the entire Maumee River Basin. The stream degenerates rapidly at Lima, Ohio, and never recovers. Thirty-three miles below Lima the water is still highly colored, ranging at times from red-orange to black. Oil is normally in evidence along the banks.

As the Ottawa River nears Lima its water quality is degraded by the effluent from septic tanks and agricultural runoff. The DO was below 4 mg/l 16 percent of the time and the minimum DO was zero. What flow there is in this stretch of the river during low flow months is utilized by Lima to augment its water supply. The small amount of water that flows through Lima is further impaired by the discharge of phenols from Republic Creosote.

GPO 827-431-6

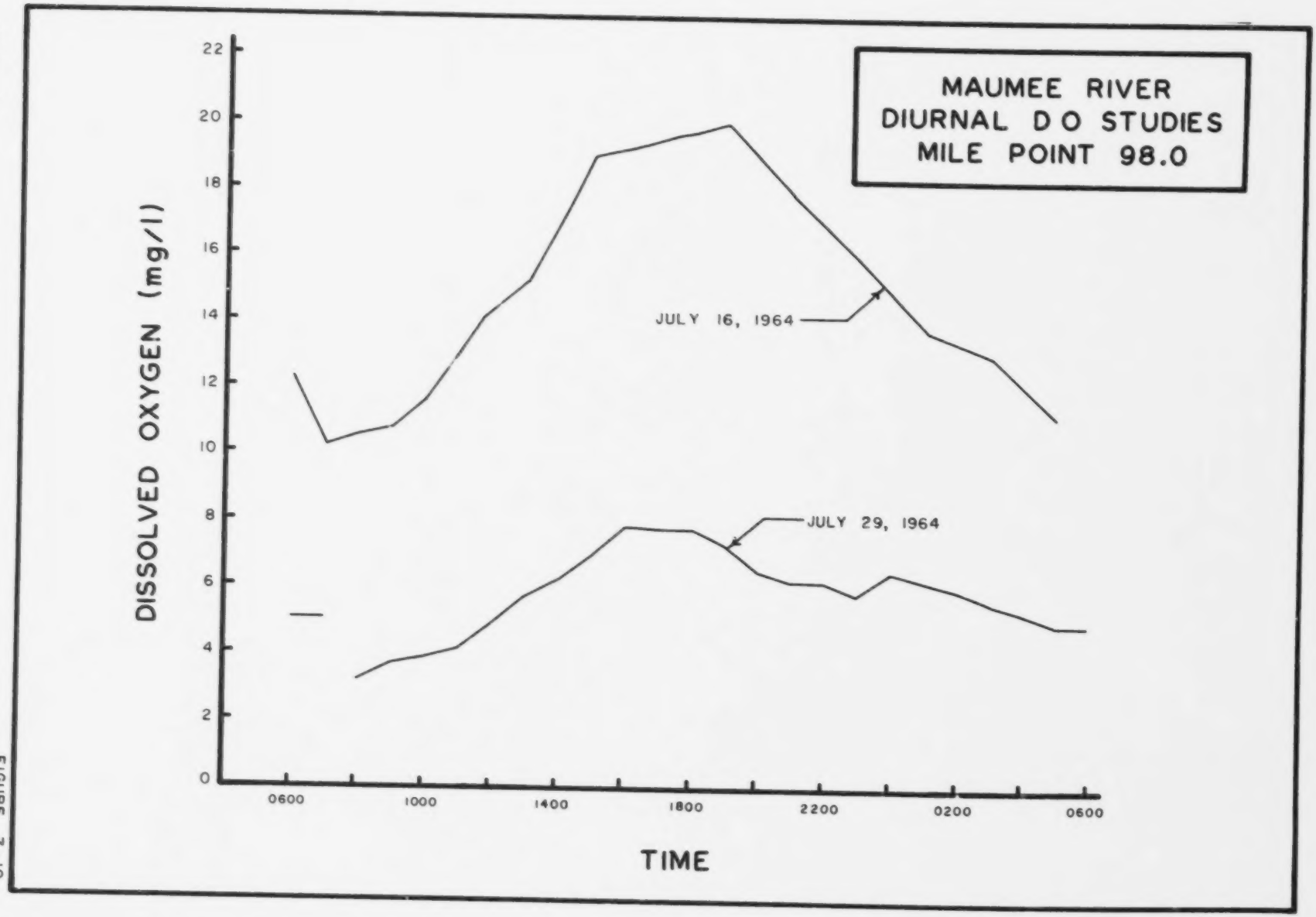


FIGURE 7-10

GPO 827-431-5

Below Lima, the flow in the Ottawa River is composed entirely of the effluent from Lima's secondary sewage treatment plant and the effluent from Sohio's chemical and petrochemical plants and refinery.

The heavy chemical pollution from this area adversely affects water supplies not only on the Ottawa, Blanchard, and Auglaize Rivers, but all the way down the Lower Maumee River. Phenolic concentrations directly below Lima ranged from 40 µg/l to 19,000 µg/l and at the mouth from 13 µg/l to 1,400 µg/l. Chemical oxygen demand (COD) values ranged from 30 mg/l to 540 mg/l below Lima and from 35 mg/l to 515 mg/l at the mouth. Concentrations of ammonia ranged from 22 mg/l to 127 mg/l below Lima with a median value of 63 mg/l. One mile above the mouth of the Ottawa River, ammonia concentrations ranging from 12 mg/l to 136 mg/l were detected with a median value of 60 mg/l. Below Lima the DO was less than 4 mg/l 80 percent of the time with many zero values recorded.

Severe bacterial pollution exists at all points sampled along the Ottawa River. Four miles below Lima the median concentration per 100 ml of Total Coliform, Fecal Coliform, and Fecal Streptococci was 350,000; 165,000; and 5,500 respectively.

Below Lima, rooted aquatic plants, attached algae, and bottom-dwelling animals were completely absent in all seasons. The stream bottom is rock and shale which in the spring is scoured clean of any silt or sludge. During low flow in the summer and fall, a black, oily sludge with a strong petrochemical odor accumulates over the stream's bottom. Between Lima and the confluence with the Auglaize River, the Ottawa River showed no signs of biological recovery. The only aquatic life observed in this reach was a very sparse population of sludgeworms and midge larvae near the mouth. The complete absence of attached algae and bottom-dwelling animals indicates not only severe oxygen deficits, but the presence of highly toxic chemicals.

Sohio is now incinerating the wastes from their acrylo-nitrile plant at a cost of one million dollars a year, and **is constructing aerated ponds to provide additional treatment for their refinery wastes. This installation should be completed by the summer of 1967.**

Blanchard River

The water quality in the Blanchard River varies from good to excessively polluted. Samples collected from the Blanchard River reveal two critical areas. The first is immediately below the City of Findlay's sewage treatment plant. Dissolved oxygen values below 4 mg/l occurred about 35 percent of the time. The water quality is severely degraded as indicated by the presence of only the pollution-

tolerant sludgeworms, midge larvae, and air breathing snails. The stream bottom is silt and gravel with sludge banks along the edge. Sewage solids have been observed floating in the water.

During the months of August-September, the river flow is composed mainly of the effluent from the sewage treatment plant. The river recovers rapidly and two miles below the sewage treatment plant the biota are typical of those found in a recovery zone.

The other critical area occurs below Ottawa, Ohio. In addition to the municipal effluent from the city, the Buckeye Sugar Co. Inc. has in the past discharged a waste containing a BOD of 2,160 pounds per day. The high oxygen demand of these wastes caused the dissolved oxygen in the Blanchard River to fall to zero for a stretch of some 20 miles downstream to the point of confluence with the Auglaize River. This occurred in the fall of 1964.

On the Blanchard River below Ottawa, the average dissolved oxygen was 4.8 mg/l during June-September, and zero in October and November. These conditions were the same at every sampling station to the confluence with the Auglaize River.

Below Ottawa, the median total coliform densities increased from 290,000 organisms per 100 ml during the June-September period to 3,400,000 during the October-December period. The highest value recorded during this period was 114,000,000 coliform organisms per 100 ml.

Biological surveys confirmed these findings of gross pollution. In October, conditions typical of a grossly polluted stream were observed. A strong odor of hydrogen sulfide permeated the area. The water was black, and the rocks in the stream were covered with black scum. Only the most tolerant forms of biological life were found throughout the length of the river to its mouth.

Auglaize River

The main stem of the Auglaize River above the confluence with the Ottawa River is acceptable except in a stretch below Wapakoneta. In the lower areas, the Auglaize is severely degraded by wastes entering from the Ottawa and Blanchard Rivers.

The Auglaize River above Wapakoneta supports a well-balanced biological population at all seasons of the year. Pollution-sensitive species of mayflies, caddis flies, and scuds were common. At Wapakoneta the Auglaize receives the effluent from the sewage treatment plant, two packing companies, a Pepsi-Cola bottling

plant, and the Monarch Battery Company. No records on the effluents from these industries have been made available. The dissolved oxygen below Wapakoneta falls to zero during low flow periods. The dissolved oxygen downstream was below 4 mg/l approximately 31 percent of the time. During the period October-December, 1964, the median coliform density was 140,000 organisms per 100 ml, with a range of 1,200 to 11,000,000.

Below the town, the water quality is severely degraded. Although bottom fauna of pollution-sensitive mayflies, caddis flies, and dragon flies were found to be fairly numerous in the spring of 1964, by July all pollution-sensitive organisms had been eliminated and only sludgeworms and midge larvae remained. The stream bottom which had been scoured clean of silt and organic deposits during the spring was covered with black, septic, malodorous sludge by July. Below this point, the Auglaize River quickly recovers and for over 50 miles, dissolved oxygen, biochemical oxygen demand, microbiological and biological data gave little evidence of organic pollution.

Below the confluences with the Ottawa and Blanchard Rivers, another dissolved oxygen sag occurred. This is the most critical area of poor water quality on the Auglaize River. During the summer, dissolved oxygen concentrations averaged 2 to 3 mg/l; during low flow in the fall season, it frequently dropped to below 1 mg/l. At mile point 25.6, located directly below the confluence of the Blanchard River, the biochemical oxygen demand ranged from 4 to 40 mg/l while phenol concentrations averaged about 28 µg/l (micrograms per liter). The maximum value of phenol was about 140 µg/l.

During the summer, extensive algal growths were observed on the Auglaize River. Stream sampling indicated that, during the warm months, such compounds as phenols and organics were rapidly assimilated. During the winter months, the colder stream temperatures allow greater concentrations of these organic compounds to reach the Maumee River. Ammonia concentrations which averaged less than 2 mg/l during July and August 1964 in this area rose to a median concentration of 42 mg/l, and as high as 84 mg/l during October to December. These results reveal that the Auglaize is severely affected by the Ottawa and Blanchard Rivers during periods of low flow and low stream temperatures.

Five miles downstream the Auglaize deepens and the velocity decreases due to the pool formed by an old power dam at mile point 5.4. At mile point 14.8 bottom animals were limited to sludgeworms and midge larvae. Only the most tolerant bottom dwellers survive. In the lake behind the dam, phytoplankton productivity is high and oxygen supersaturation often occurs at the surface.

Substantial winter fish mortalities of shad and other rough fish have been observed in the lower reaches of the Auglaize during the past four years. Since low dissolved oxygen was not a problem at that time of year the kills most likely resulted from the large ammonia concentrations mentioned previously. (Table 7-1)

TABLE 7-1

FISH KILLS - MAUMEE RIVER BASIN (OHIO)*
1964-1965

River	County	Fish Killed	Pc lutant
Blanchard	Hancock	6,839	Sewage, Municipal
Blanchard	Hancock	720	Sewage, Municipal
Blanchard	Hancock	1,245,374	Sewage, Municipal
Blanchard Trib.	Putnam	1,627	Silo Drainage
Blanchard	Putnam	494,499	Sugar Beet Waste
Riley Creek	Putnam	11,163	Unknown
Auglaize	Auglaize	43,836	Sewage & Industrial
Jennings Creek	Van Wert	76	Industrial
Little Auglaize	Van Wert	14,533	Pipeline Break
Auglaize	Defiance	769,606	Unknown
West Branch Deer Cr.	Fulton	2,004	Manure
Jackson Ditch	Wood	62,607	Oil & Liquid Fertilizer
Maumee	Lucas	361,418	Sewage, Municipal
Tenmile Creek	Lucas	4,855	Unknown

* From Ohio Department of Natural Resources, Division of Wildlife Pollution Investigation, 1964-1965.

The Little Auglaize River, Flatrock Creek, and Sugar Creek exert little, if any, effect on the main stem of the Auglaize **from sources other than agricultural pollution.**

Town Creek is a tributary to the Little Auglaize River. Samples from this stream collected at a point below Van Wert, Ohio, revealed gross pollution during low flow. The dissolved oxygen dropped to zero in the summer. Samples collected were septic and foul smelling. Coliform densities exceeding 50,000,000 organisms per 100 ml were found.

Lower Maumee River

The water quality in the Lower Maumee River (confluence of the Tiffin River to mile point 15) is fair to severely polluted. Taste and odor problems in the water are severe in this area.

Cities situated on or near the Maumee River draw their raw water supply from the highly polluted waters of this stream. Taste and odor problems are prevalent throughout most of the year in the water supplies at Defiance, Napoleon, Bowling Green, and other cities. At Defiance, during periods of low temperatures and ice cover, problems are encountered with phenolic compounds. The finished water imparts a medicinal taste and odor enhanced by chlorination. During the period of Spring runoff, the water has an intense earthly or musty taste. During late Spring in 1963, 1964 and 1965, there were periods of exceptionally severe taste and odor problems. The water during these periods was described variously as musty, moldy, earthy, fishy, and "rotten".

The taste and odor problems at Napoleon are similar to those in Defiance with the exception of additional interference from ammonia compounds from the Auglaize River. Campbell Soup Company has reported excessive taste and odor problems at times. Large concentrations of ammonia at the plant have created peak chlorine demands as high as 150 mg/l. The company reports that the quality of its raw water supply has continued to deteriorate in recent years.

The main sources of ammonia, nitrates and phenols to the waters in this area are: surface runoff from agricultural sources, and the discharges of: the Fort Wayne area, Sohio industrial plants and Johns-Manville Fiberglass Company through the Defiance Sewage Treatment Plant

Above the City of Defiance, Ohio a dissolved oxygen deficit occurs. This point is above the confluence with the highly polluted Auglaize River and the Defiance Sewage Treatment Plant. This deficit is attributed to the large number of unsewered or faulty sewered residences in this area discharging raw sewage into the Maumee River. Also, the sewage collection system is faulty in that the sewage treatment plant is closed 30 to 60 days each year. As the river stage rises 5 feet above normal, water is backed up in the main lift station closing the main interceptor and sewage is bypassed directly to the river 2 miles above the plant.

The sewage treatment plant at Defiance provides only primary treatment facilities. An industrial and municipal waste survey by the State of Ohio indicated 1,770 lbs./day BOD and 6,750 lbs./day

total solids in the final effluent. Phenol concentrations in the range of 14,000 - 22,000 ug/l were recorded, which averaged about 100 lbs. of phenol discharged per day. Most of the industry in Defiance is sewered. However, primary treatment cannot assimilate the heavy loading of phenolic compounds from the Johns-Manville Fiberglass Company.

At Napoleon, Ohio, wastes discharged to the Maumee River originate from one major source. The Campbell Soup Company discharges an estimated 4,620 pounds of BOD daily during the winter months only.

Municipal wastes are also discharged to the Lower Maumee by the communities of Perrysburg and Waterville. The sewage treatment plant at Perrysburg has only primary treatment while Waterville has a secondary plant.

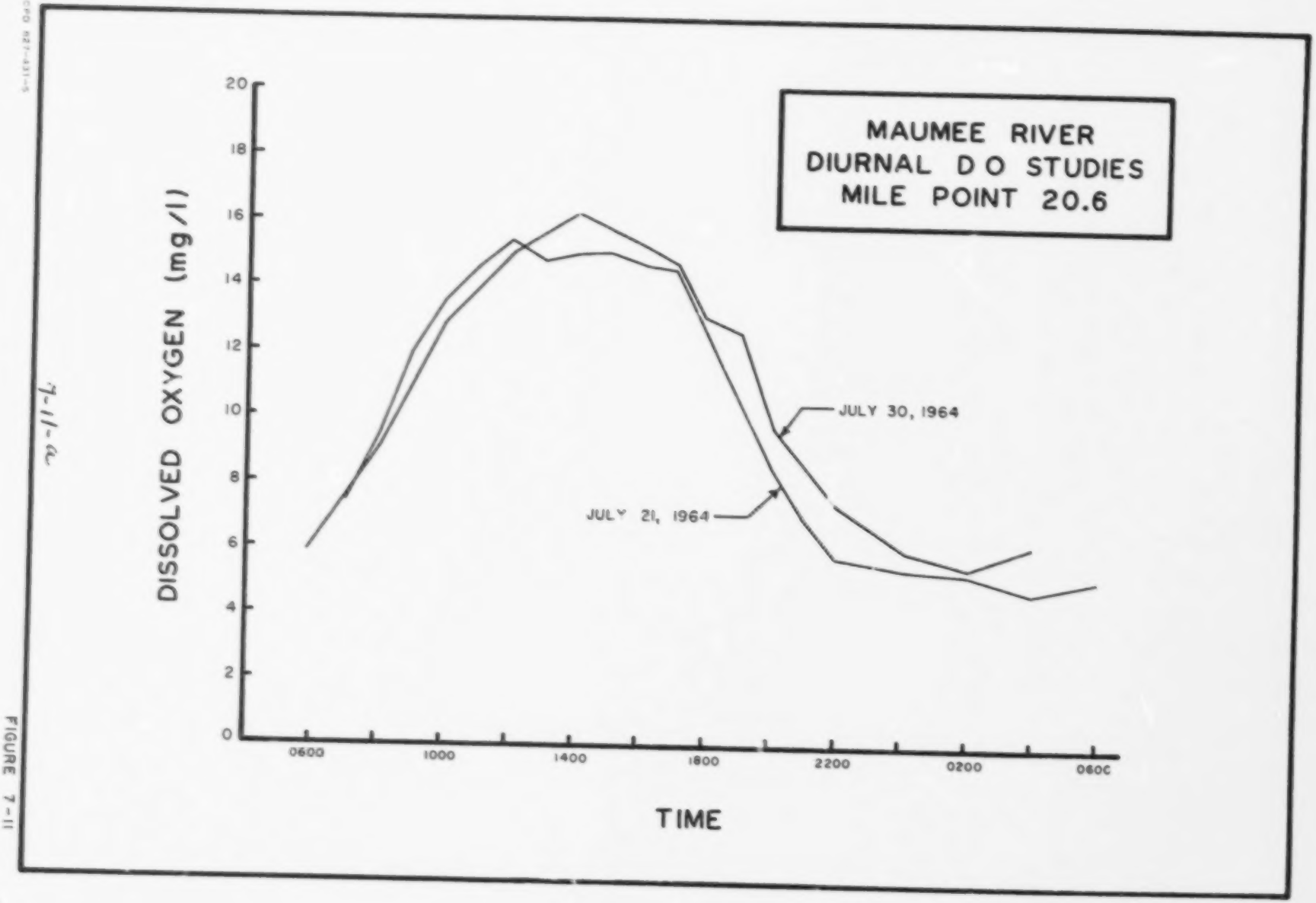
The extensive growth of blue-green and green algae throughout this entire stretch also helps produce taste and odor problems. Phytoplankton counts in excess of 100,000 per ml were found in the summer of 1964. Table 7-2 is a tabulation of the plankton counts at mile point 65 from October 1964 to June 1965.

During the same period (October 1964-June 1965) diurnal DO studies showed considerable vertical and diurnal variations. Values as high as 10 mg/l were often found at the surface while the bottom waters contained only 0.5 mg/l. Diurnal variations gave early morning concentrations of 8.0 mg/l at the surface and 25 mg/l in the afternoon. The low DO values at the bottom confirmed the absences of any intolerant animals on the stream bottom. Figure 7-11 shows the diurnal curve for mile point 20.6 on two dates in 1964.

Toledo Channel, Harbor, and Lakefront

Lake level fluctuations have been found to affect the Maumee River as far as 15 miles upstream; therefore, pollution which enters the Maumee at one point in this lake affected area may degrade the water quality several miles upstream.

Sediment is a problem in the navigation channel, which extends approximately seven miles upstream from the mouth of the River and must be continuously dredged. The suspended sediment is extremely fine and stays in suspension for long periods of time. The Maumee discharges over 1.4 million tons of sediment a year to Lake Erie.



7-11-a

FIGURE 7-11

TABLE 7-2

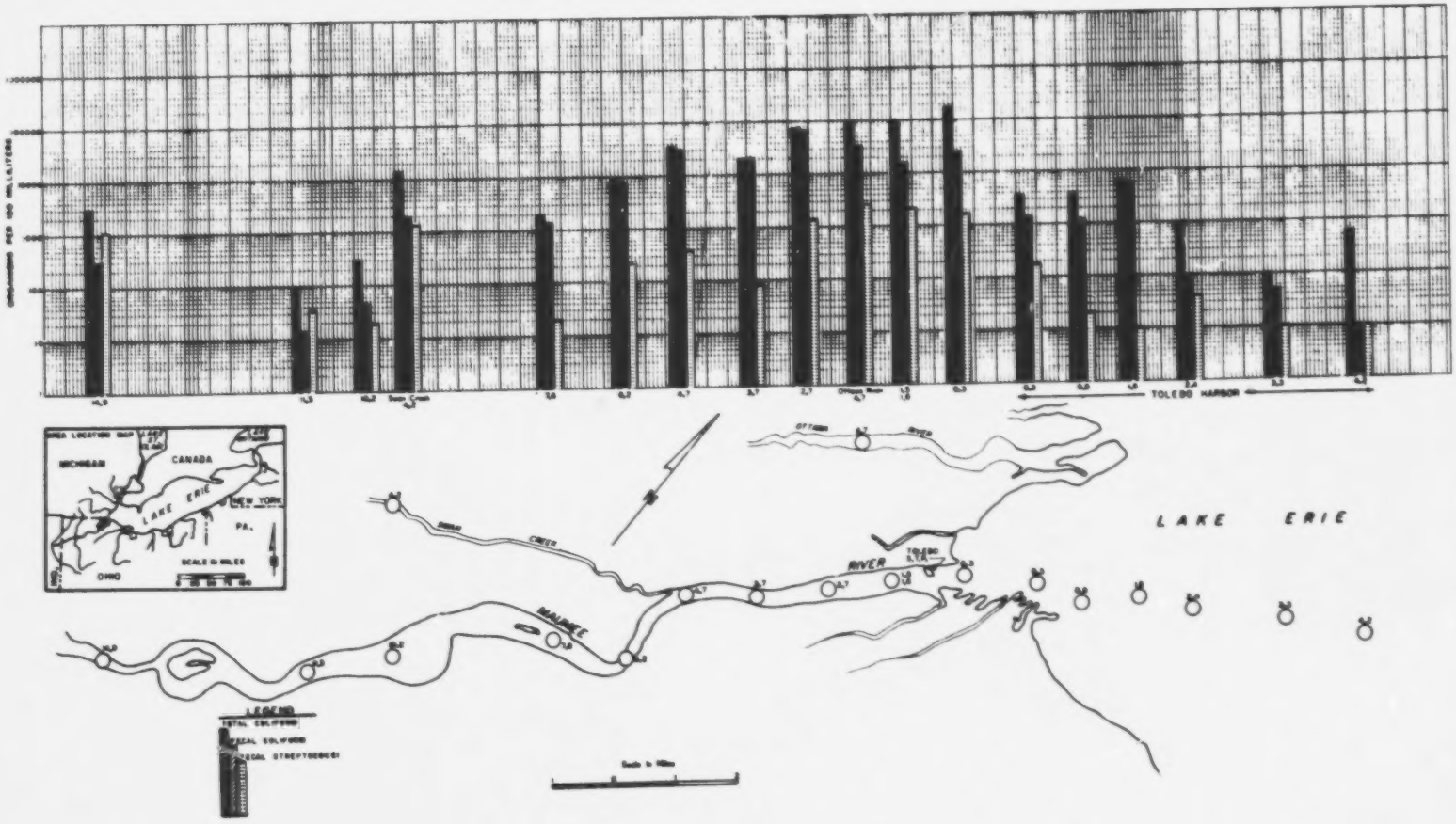
PLANKTON COUNTS AT MILE POINT 65.0 ON THE MAUMEE RIVER

AT DEFIANCE, OHIO
(Numbers per ml)

Date	Diatoms		Green		Blue-green		Total
	Centric	pennate	coccoid	flag-ellate	coccoid	fila-mentous	
10-29-64	35,952	17,136	61,488	448	11,200		126,224
12-23-64	5,670	1,755	1,755	1,305		900	11,385
12-28-64	4,888	585	630			45	5,948
1-12-65	900	4,185	540	315	270	180	6,363
1-23-65	45	607	67	22	22	22	785
3-8-65	Too turbid to count						
4-4-65	360	505	315	135	450	270	2,035
4-21-65	360	90	135	45	45	45	720
4-23-65	270	405	90	180	45	135	1,125
5-4-65	1,688	1,123	741	88	112	742	4,498
5-18-65	1,710	1,845	1,395	315	450	315	6,030
5-27-65	12,960	3,115	9,945	675	3,375	1,080	30,096

The waters in the naviation channel and lake front areas are severely polluted. Very high bacterial densities were found in these waters, with median densities of total coliform, fecal coliform, and fecal strep in excess of 100,000; 11,000; and 1,100 organisms per 100 ml respectively. As can be noted in Figure 7-12, fecal coliform were the prime coliform present in the lower eight miles of the Maumee River. The existence of human enteric pathogenic microorganisms were also revealed. Salmonella was detected 40 per cent of the times sampled, confirming the health hazard to persons exposed to these waters. A partial listing of Salmonella serotypes isolated is given in Table 7-3.

Swimming, water skiing, boating,and other water contact sports are among the uses impaired by pollution in the area. A health hazard exists due to the presence of human enteric pathogens. The Lucas County Health Department recommends against swimming in any beach areas west of Crane Creek State Park - and warns against swimming at the Park under certain wind conditions.



7-12-a

TOLEDO AREA TOTAL
COLIFORM CONCENTRATION

FIGURE 7-12.

TABLE 7-3

ISOLATIONS OF SALMONELLAE-LOWER MAUMEE
January 15 - April 1, 1964

Sampling Site	Date of Collection	Salmonella Serotypes (isolates)
Tenmile Creek 004.7	1-21-64	Salmonella cubana (1)
	1-28-64	--
	2-18-64	Salmonella infantis (1), chester (1)
	3-31-64	Salmonella tennessee (4), thompson(2)
Tenmile Creek 010.2	1-28-64	--
	2-18-64	Salmonella worthington (1)
	3-10-64	--
Maumee River 001.6	2-18-64	Salmonella infantis (1)
	3-10-64	Salmonella tennessee(2), oranienburg(1)
Maumee River 014.9	1-21-64	--
	2-5-64	--
	3-10-64	--

The major sources of bacterial pollution in the Toledo area are from combined sewer discharges and the Toledo Sewage Treatment Plant. Even though this plant provides secondary treatment, its effluent contains over 18,000 pounds of BOD_5 daily. This is equivalent in oxygen demand to the raw sewage from a city of 90,000.

In addition to the effluent from the Toledo treatment plant, industrial wastes are being discharged throughout this lower reach. These discharges contain oil, phenols, solids, color, BOD, and COD. The following industries are the major contributors of oil or phenols; Standard, Pure, Gulf, and Sun Oil Companies and Interlake Steel. With all these wastes being contributed to the Maumee River and Maumee Bay, recreational use of these waters is severely damaged in the Toledo area.

The City of Toledo obtains its water supply from an intake located in Lake Erie approximately 9 miles east of the Maumee River. Toledo water is occasionally affected by Maumee River water. Its problems are not on the same scale as those cities whose source is exclusively the Maumee River. But,it is estimated by the City of Toledo that during some Spring runoffs, the Toledo intake will receive 70 to 90 per cent of its water from the Maumee. When this happens, hardness and alkalinity levels increase and occasional blooms of algae increase the taste and odor problems. These blooms are fed by the large amount of nutrients being contributed to the Bay by the Maumee and also from the Toledo Sewage Treatment Plant.

CHAPTER 8

QUALITY IMPROVEMENT MEASURES

General

The problems of water pollution control in the Maumee River Basin are complex. Solutions to these problems will, of necessity, involve a program which includes construction of new treatment plant facilities, expansion of present facilities, and continuous and intensive monitoring of operations to maximize treatment plant efficiency. In addition, flow regulation may be required to maintain the water quality in sections of the Basin even after advanced or tertiary waste treatment is accomplished. The phases of a program for pollution control in the Maumee River Basin are discussed in the following paragraphs.

Municipal Waste Treatment

There are approximately 45 municipal sewerage facilities in the Maumee River Basin. Of these, 36 provide secondary biological waste treatment. Municipal waste treatment construction needs for the major communities of the Maumee River Basin are shown in Table 8-1.

The immediate goal in the treatment of municipal wastes is the provision of at least biological (secondary) treatment. Such treatment provides 90 percent BOD_5 removal and is considered adequate in many parts of the Basin. To regain the desired water quality, tertiary or advanced treatment must be added to the present secondary systems in several areas. Adequate effluent disinfection is considered to be a necessity in the study area, particularly where recreational use of the receiving waters is prevalent or desired. There is also a major present need for increased phosphate removal. The waste collection systems in the metropolitan areas must be expanded to include the suburban areas which now lack treatment or discharge their septic tank effluents to the area's waters.

Industrial Waste

Table 8-2 lists the immediate industrial waste treatment needs for the Maumee River Basin. The waste discharge loadings from several of the industries listed are small, but due to the extreme low flows in many areas of the Basin these loadings are quite important.

As with domestic wastes, industrial wastes require a very high degree of treatment in many of the subbasins of this region in order

TABLE 8-1

MUNICIPAL WASTE TREATMENT NEEDS
MAUMEE RIVER BASIN

Sewerage Service Area	Present Treatment	Present Population	Plant Needs
	MICHIGAN		
St. Joseph River			
Reading	Minor	1,130	Secondary & Disinfection
Tiffin River			
Hudson	Secondary	2,550	Expansion
Morenci	Stabilization Lagoons	2,055	None
	INDIANA		
St. Joseph River			
Auburn	Secondary	6,350	None
Butler	Secondary	2,170	Disinfection
Garrett	Secondary	4,364	None
Waterloo	Secondary	1,432	Disinfection
St. Marys River			
Berne	Stabilization Lagoons	2,644	Disinfection
Decatur	Secondary	8,327	None
Upper Maumee Rvier			
Diversified Utilities, Inc.	Secondary	4,200	Expansion
*Fort Wayne	Secondary	171,780	Advanced Waste Treatment
New Haven	Secondary	3,396	Disinfection
	OHIO		
St. Joseph River			
Edgerton	Minor	1,566	Secondary & Disinfection
*Montpelier	Primary	4,131	Secondary & Disinfection
St. Marys River			
New Bremen	Secondary	1,972	Expansion & Disinfection
Rockford	Primary	1,155	Secondary & Disinfection
*St. Marys	Secondary	7,737	Advanced Waste Treatment

* Indicates sewage treatment plants receiving significant industrial loads.

TABLE 8-1 (continued)

MUNICIPAL WASTE TREATMENT NEEDS
MAUMEE RIVER BASIN

Sewerage Service Area	Present Treatment	Present Population	Plant Needs
Auglaize River			
Ada	Secondary	3,918	Expansion & Disinfection
Bluffton	Secondary	2,591	Disinfection
*Columbus Grove	Secondary	2,104	Advanced Waste Treatment
Continental	Secondary	1,147	Disinfection
Cridersville	Secondary	1,053	Disinfection
*Delphos	Secondary	6,961	Advanced Waste Treatment
Dunkirk	Minor	1,006	Secondary & Disinfection
Elida	Minor	1,215	Secondary & Disinfection
*Findlay	Secondary	30,344	Advanced Waste Treatment
Forest	Minor	1,314	Secondary & Disinfection
*Lima	Secondary	51,037	Advanced Waste Treatment
Ottawa	Secondary	3,245	None
Paulding	Stabilization Lagoons	2,936	Disinfection
Payne	Minor	1,287	Secondary & Disinfection
Spencerville	Secondary	2,061	Disinfection
*Van Wert	Secondary	11,323	Advanced Waste Treatment
*Wapakoneta	Secondary	6,756	Advanced Waste Treatment
Tiffin River			
*Archbold	Secondary	2,348	Advanced Waste Treatment
*Bryan	Secondary	7,361	Advanced Waste Treatment
Fayette	Stabilization Lagoons	1,090	Disinfection
Stryker	Stabilization Lagoons	1,205	Disinfection
West Unity	Minor	1,192	Secondary & Disinfection
Upper Maumee River			
Antwerp	Minor	1,465	Secondary & Disinfection
Defiance	Intermediate	14,553	Expansion
Hicksville	Secondary	3,116	Expansion
Lower Maumee River			
*Delta	Secondary	2,376	Advanced Waste Treatment
*Deshler	Stabilization Lagoons	1,824	Disinfection

*Indicates sewage treatment plant receiving significant industrial loads.

TABLE 8-1 (continued)

MUNICIPAL WASTE TREATMENT NEEDS
MAUMEE RIVER BASIN

Sewerage Service Area	Present Treatment	Present Population	Plant Needs
Lower Maumee River (continued)			
Holgate	Minor	1,374	Secondary & Disinfection
Leipsic	Secondary	1,802	Disinfection
Napoleon	Secondary	6,739	None
Perrysburg	Intermediate	5,519	Secondary
Swanton	Secondary	2,306	Disinfection
*Toledo	Secondary	318,000	Advanced Waste Treatment
Waterville	Secondary	1,856	Expansion & Disinfection
Wauseon	Secondary	4,311	Advanced Waste Treatment
Weston	Secondary	1,075	Disinfection
*Whitehouse	Secondary	1,135	Expansion
Minor Tributaries			
Tenmile Creek (Ottawa River)			
Sylvania	Secondary	5,187	Expansion
Silver Creek			
Trilby	Minor	5,000	Secondary & Disinfection

*Indicates sewage treatment plant receiving significant industrial loads.

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TABLE 8-2

INDUSTRIAL WASTE TREATMENT NEEDS
MAUMEE RIVER BASIN

Industry	Location	Control Measures
	Lower Maumee	
Toledo Edison	Toledo, Ohio	General Control Measures & Improvements
Gulf Oil Company	Toledo, Ohio	COD, Oil
Sun Oil Company	Toledo, Ohio	Solids
Pure Oil	Toledo, Ohio	Oil, COD, and Phenols
Standard Oil Company	Toledo, Ohio	Phenols, Oil, COD
Libbey-Owens-Ford	Toledo, Ohio	Oil, Solids, Color
Interlake Iron	Toledo, Ohio	Phenols, Solids
Johns-Manville Company	Waterville, Ohio	Solids, BOD, Phenol
Campbell Soup Company	Napoleon, Ohio	BOD
Central Foundry(Div.GM)	Defiance, Ohio	Solids, BOD
S. K. Wayne Tool Co.	Defiance, Ohio	General Control Measures
	Upper Maumee	
Weatherhead Corporation	Antwerp, Ohio	Oils and Solids
	Auglaize	
Hayes Industry - Decorative Division	Spencerville, Ohio	Solids
Ohio Decorative Products	Spencerville, Ohio	Solids, Housekeeping
	Blanchard	
Buckeye Sugars	Ottawa, Ohio	BOD
National Refinery (Ashland Oil)	Findlay, Ohio	Oil, General Housekeeping
Rusco Inc.	Pandora, Ohio	Oil, Solids, Secondary Treatment of sewage
	Ottawa	
Excello Corporation	Lima, Ohio	General Housekeeping
Ford Motor Company	Lima, Ohio	Oil
Republic Creosote	Lima, Ohio	Phenol
Standard Oil Company		
Refinery	Lima, Ohio	Phenol, Oil, COD
Chemical	Lima, Ohio	Ammonia
Petrochemical	Lima, Ohio	Evaluate Completed Improvements

TABLE 8-2 (continued)

INDUSTRIAL WASTE TREATMENT NEEDS
MAUMEE RIVER BASIN

Industry	Location	Control Measures
	St. Joseph	
Edgerton Metal Products	Edgerton, Ohio	Chrome Treatment, Acid Neutralization
	St. Marys	
Weston Paper	St. Marys, Ohio	BOD
Goodyear Tire & Rubber Company	St. Marys, Ohio	General Housekeeping
Beatrice Foods Company	St. Marys, Ohio	General Housekeeping
Essex Wire Company	Fort Wayne, Ind.	Phenol
	Tenmile Creek	
Dana Corporation	Toledo, Ohio	Oil

to provide suitable stream conditions. Most industries in the Basin are aware of the acute problems caused by their wastes and have programs which, when put into effect, will all but eliminate their waste problems. SOHIO at Lima is spending over a million dollars a year on just the operating costs of its treatment facilities. Besides BOD, the main industrial problems in the Maumee Basin are caused by oils, phenols, ammonia, and solids.

Combined Sewers

Studies of combined sewer systems have indicated that the combined overflow contains from 3 to 5 percent of the average annual untreated domestic sewage. During storms, as much as 95 percent of the sewage flow is discharged with the storm water runoff. Storm water alone has been shown to carry significant amounts of the pollutional load, particularly in the early portions of storms when a flushing action occurs resuspending the deposited sludge in the sewers.

The need for solutions to the problems caused by overflows of combined sewer systems is pressing and is receiving much current attention. The Water Quality Act of 1965 established a four-year program of grants and contract authority to demonstrate new or improved methods to eradicate the problems of combined sewer overflows. Combined sewers should be prohibited in all newly developed areas and in urban renewal projects.

Reduction of Nutrients

Nutrients and the effect they have on producing algal growths have been considered earlier in this report. There is an immediate and continuing need for the reduction of the nutrient loads to the Maumee Basin. The suggested critical phosphate (PO_4) concentration of 0.03 mg/l was exceeded in almost every sample collected throughout the Maumee Basin. Excluding the discharges from the City of Toledo, the Maumee River discharges approximately 24 million pounds per year of total phosphates (of which 9 million pounds per year are soluble phosphates) into Lake Erie. It is estimated that the City of Toledo's treatment plant discharges over 3 million pounds of soluble phosphates per year.

The degree of phosphate removal obtained by the municipal and industrial treatment plants in the Maumee River Basin is not yet known; however, the removal of phosphates is known to vary among plants of similar design for reasons that are not always evident. Research in progress shows promise of accomplishing substantial removals at nominal costs.

From the conditions found in the Maumee Basin and in Lake Erie, it is evident that it is of the utmost importance to remove as much phosphate as possible as soon as possible in the Basin. Phosphates from all sources must be reduced or eliminated. The need to reduce phosphates from agricultural uses through soil conservation practices is equally as important as removing the phosphates from domestic sewage.

Plant Operation

Proper plant operation must follow proper plant design in order to efficiently reach the goals of water pollution control. The importance and value of proper plant operation must be emphasized at all levels of public authority. Effective operation can be encouraged by means of a routine inspection program. Inspections should be conducted by the appropriate State agencies on at least an annual basis for the small and medium-sized plants, and at least bi-annually for the larger plants.

A mandatory sewage treatment plant operators' certification program should be adopted in Indiana. The Ohio Department of Health should have stronger enforcement powers to carry out present regulations requiring operator certification. The State of Michigan already has a satisfactorily operating mandatory program.

Monthly operation reports should be submitted to the States water pollution control agencies from each municipal and industrial waste treatment facility. These reports should contain sufficient information to describe waste treatment efficiency and the quality and quantity of the effluent discharged to the water of the Maumee River Basin. Monthly operational reports would provide the State with more current information and would enable it to take much quicker action concerning needed improvements. This information should be reported in terms of both concentrations and load rates, and should be maintained in open files by the State agencies for use by those having a legitimate interest in the information.

Monitoring

The maintenance of desirable water quality on a continuing basis calls for a routine monitoring program covering the significant water quality parameters at strategic points. The State of Indiana has an

examplary monitoring program in its portion of the Maumee River Basin. Since 1957 it has collected bi-weekly samples from one station each on the St. Joseph, St. Marys, and Maumee Rivers, and published this material in an annual tabulation of the water quality of the State.

The water quality monitoring program of the Ohio Water Pollution Control Agencies in the Maumee River Basin needs to be strengthened. At present the State of Ohio has a limited routine sampling program for the Ohio portion of the Maumee River Basin. A monitoring program should be geared to indicate any changes or trends in water quality and the need for additional quality improvement measures.

The total water pollution control activities in Indiana and particularly in Ohio should be strengthened in terms of staffing and budget. With additional resources and the support available from the FWPCA, the implementation of the program outlined in this report and similar programs in other basins throughout the States can be accelerated to meet the growing needs for clean water.

The industries, municipalities, and other agencies discharging wastes within the study area should submit reports to the appropriate State agency concerning the quality and quantity of waste discharged. These reports should be combined with the monthly operating reports discussed in the previous section.

The overall monitoring program in the Maumee River Basin should be geared to provide an adequate picture of all wastes being discharged to the waters of the area and serve to indicate trends in water quality or the need for additional quality improvement measures.

Flow Regulation

As discussed in Chapter 4, the Maumee River Basin suffers from extreme low flow during periods of the year. With the lack of reservoir sites it is unlikely that a source of flow augmentation will be found within the Basin. In a study conducted by the State of Ohio's Development Department, a pipeline to distribute Lake Erie water throughout the Maumee Basin was proposed (28). This water would be used for both domestic and industrial water supply and possibly for flow augmentation. It is not recommended that flow augmentation be used as a substitute for treatment measures recommended in this report, but it is recognized that flow regulation may still be required even after a high degree of treatment is obtained.

State Water Pollution Control Program

The Federal Water Pollution Control Act recognizes the primary

responsibility of the States in the control and prevention of water pollution. The effectiveness of a State program, however, is dependent upon adequate funds and personnel with which to accomplish this mission.

The States of Indiana, Michigan, and Ohio have achieved commendable success in the control of water pollution with the staff and funds available. However, though much has been accomplished by the States in controlling conditions, much remains to be done. In 1964, the Public Administration Service prepared a report, "Staffing and Budgetary Guidelines for State Water Pollution Control Agencies". The guidelines given in that report include the following:

> For states in the population group of Indiana, desirable staff of about 100 people and an annual budget of a million dollars; for states such as Ohio, in a much larger population group, approximately twice the numbers, i.e., 200 people and 2 million dollars a year; for states intermediate in population comparable guideline numbers are 170 people and 1.6 million dollars. (64)

CHAPTER 9

BENEFITS

Implementation of the recommendations which comprise the above action program will result in substantial improvement in the quality of the waters in the Maumee River Basin. The program objectives, however, are more specific and have been developed to provide water of satisfactory quality for both present and planned uses as shown in Table 5-2. Accomplishment of program objectives will result in both tangible and intangible benefits to the people of the Maumee River Basin in particular, and to the people of the States of Indiana, Michigan, Ohio, and the Nation as a whole. As the waters of Lake Erie serve many states and are of national importance, all will share in the benefits resulting from the enhancement and protection of these waters for both present and future needs.

The 1.2 million people who will reside in the Basin by 1980 will benefit from the assurance of a safer, more palatable water supplied to their homes, business establishments, industries, schools, and public buildings. Owners of property adjacent to and near bodies of water will derive increased esthetic enjoyment and enhanced property values from the elimination of ugliness and unsightly conditions resulting from water pollution, including nuisance algal blooms stimulated by over-fertilization.

Indiana, Michigan, and Ohio residents and visitors from out-of-state who use the Basin's streams and lakes for swimming, water skiing, boating, and other water-oriented sports will be protected against infectious diseases which can be spread as a result of water pollution. The sports fisherman will find again the once vast fishing areas to challenge his skill.

In addition to these immediate and direct benefits resulting from the control of pollution, the preservation and protection of the quality of the waters of Lake Erie and the Great Lakes is essential to the Nation's continued growth and prosperity. This immense fresh water resource, the greatest in the world, is beginning to show the effects of man's carelessness. Lake Erie is a clear demonstration that size is no protection against pollution and that man has the capability of destroying the usefulness of even a major water resource. As this Lake is serving as an example of what will happen to the other Great Lakes if pollution remains unchecked, it may also serve as an example of what man can do to restore the quality of his environment and provide more useful benefits to the total population.

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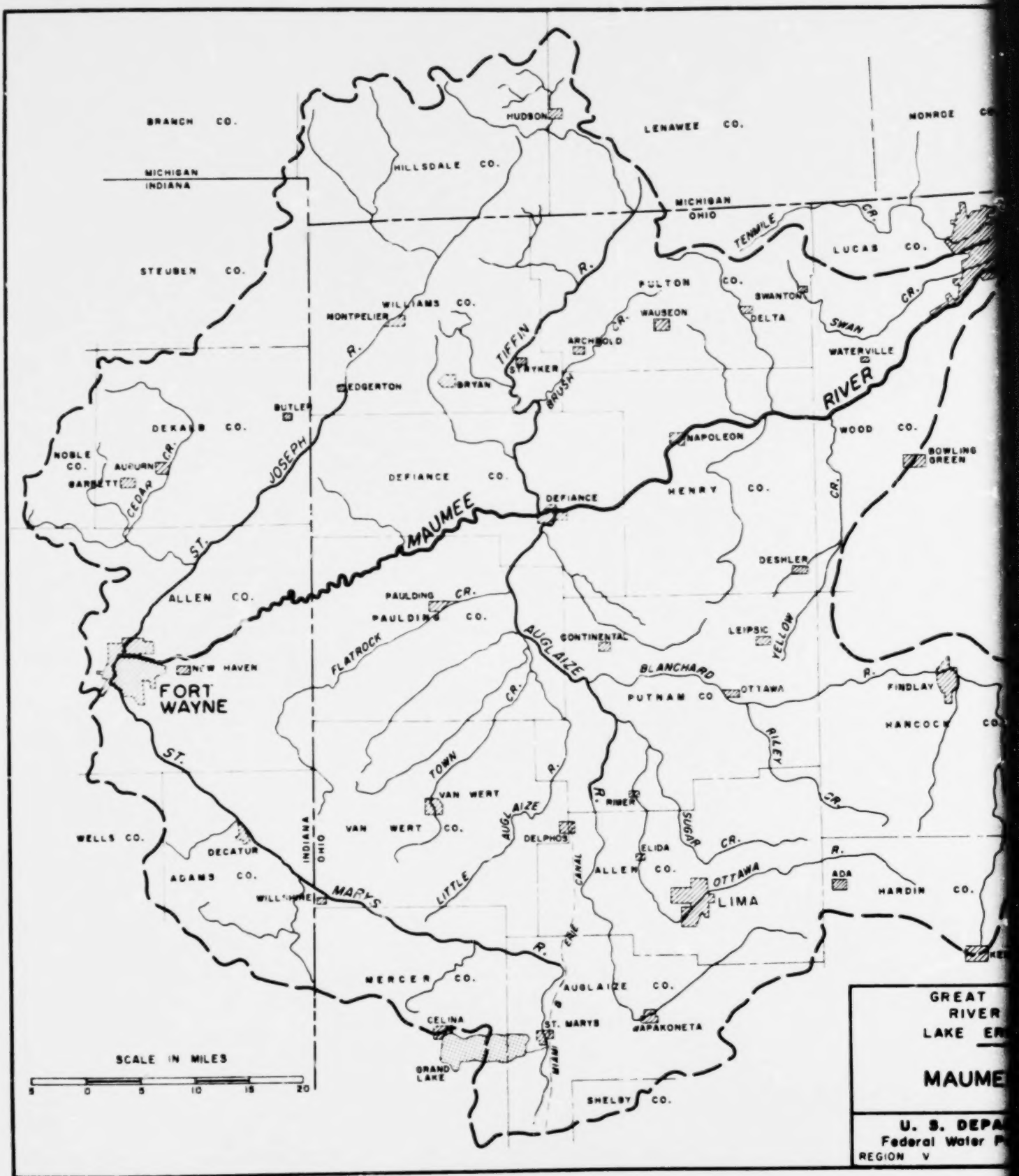
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WATERVILLE
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WOOD CO.
NOBLE CO.
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FLATROCK
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BLANCHARD
NEW HAVEN
FORT WAYNE
PUTNAM CO
OTTAWA
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Federal Water Pollution Control Administration
REGION V CLEVELAND, OHIO

FIGURE 1-3